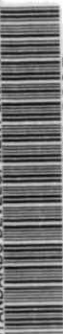


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ENVIRONMENTAL RESEARCH

RESEARCH AND TECHNOLOGY BRANCH

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Environment
Ontario

Jim Bradley, Minister





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Research needs : 1989/90 /
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RESEARCH AND TECHNOLOGY BRANCH
ENVIRONMENTAL RESEARCH PROGRAM

R E S E A R C H N E E D S

1989/90

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ENVIRONMENTAL RESEARCH PROGRAM

RESEARCH NEEDS - 1989/90

It is the intention of the Ontario Ministry of the Environment to foster and encourage excellence in Environmental Research. The Research Program is widely represented in academia and the private sector and is well respected in Canada and abroad. In the past year the Ministry has given formal recognition to the Environmental Research Program by creating the Research and Technology Branch from the former Research Management Office.

The Research and Technology Branch has prepared this document summarizing the 1989-90 scientific research priorities of the Ontario Ministry of the Environment in order to assist researchers in their submission of requests for financial assistance in support of environmental research and to ensure that the research resources of the Ministry are appropriately allocated.

Ministry research is classified in one of five research areas; Air Quality (AR), Water Quality (WA), Liquid and Solid Wastes (LS), Analytical Method Development (AN) and Socio-Economic Research (SE).

Within each classification the recognized research requirements have been listed by "category" representing a field within the classification, by an "issue" describing the problem with which the environment is faced and the "needs" which provide more detailed description of the scope of projects envisaged within that issue.

The needs listed are for guidance only and it is not intended to limit the submission of new ideas for research. Innovative proposals for work not included in the identified research needs are also invited, as are proposals that encompass more than one research classification, category, issue or need.

Two other documents, "Guide for Applicants" and "Research Management Process", are available from the Research and Technology Branch to assist researchers in preparing and submitting research proposals. Proposals will normally be submitted on or before January 15 and June 15 of each year, and will be evaluated and considered by the Research Advisory Committee at meetings held in March and September respectively. It is advisable to confirm the June 15 date with the Research and Technology Branch before submitting a proposal.

Proposals (original and five copies, including completed "Application for Research Funding" forms) should be sent to:

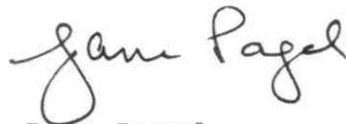
Research and Technology Branch
Ontario Ministry of the Environment
135 St. Clair Avenue West
Toronto, Ontario
M4V 1P5

Telephone: (416) 323-4574

Proposals will be evaluated on the basis of scientific merit, relevance to Ministry needs and priorities. An important consideration will be the availability of funding which is a function of the Ministry or Government budget constraints.

Successful applicants will be required to enter into a grant agreement or contract with the Ministry depending on the type of award. An annual inventory of ongoing research projects is prepared by the Research and Technology Branch and investigators are required to submit status and progress reports and to present their findings at the annual Environmental Research Technology Transfer Conference usually held in late November.

We welcome your contribution in the Environmental Research Program.

A handwritten signature in cursive script, reading "Jane Pagel".

Jane Pagel
Director
Research and Technology Branch

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AIR QUALITY RESEARCH NEEDS

AIR QUALITY RESEARCH

The Air Quality Research Needs Document reflects the Ministry's mandate to protect the environment and human health, specifically as it is related to air pollution. The current research requirements are grouped under six categories, thirteen issues, and fifty-three needs. As one might reasonably expect, many of these entries are inter-related.

The six categories fall into two groups: primary and ancillary. The former includes the three basic components in the understanding of air pollution, namely, the environmental impacts/receptor (contaminant effects/toxicology/fates), the source (sources/inventories), and the intermediate processes (atmospheric processes) between the source and receptor. The latter includes regulation (risk management and criteria development), abatement (control and remedial technology) at the source and receptor, and sampling (instrument development and application), which is necessary for source, receptor and process studies.

Each category is broken down into issues which define the area of research more concretely, e.g. contaminant effects into human, ecosystem, and phytotoxicology; and sources into industrial/commercial, stationary/domestic, and mobile sources.

Under each issue, particular research needs are listed. These needs are meant to provide general rather than specific guidance to prospective applicants. Because of the nature of the categories and issues, many of the research needs can be linked to issues other than the one under which they are grouped. Also, atmospheric research is not independent of other environmental disciplines, readers are therefore encouraged to look at other research areas cross-referenced at the bottom of each issue page.

SUMMARY OF AIR QUALITY RESEARCH ISSUES

RESEARCH CATEGORY	ISSUES	PAGE NUMBER	RELATED ISSUES AND PAGE NO.
<u>AIR QUALITY</u>			
Contaminant Effects/ Toxicology/Fates	AR01 The effects of pollution on human beings	6	SE01/ 102 AR07/ 12
	AR02 The impact of air pollution on eco-systems	7	WA20/ 43 SE01/ 102
	AR03 Phytotoxicology in identifying and quantifying the effects of air pollutants	8	WA15/ 38 SE01/ 102
Atmospheric Processes (including Source-Receptor Links)	AR04 Atmospheric dispersion of air emissions	9	WA10/ 33 WA19/ 42 LS03/ 62 SE02/ 104 SE06/ 108
	AR05 Improved emergency response capability	10	AR11/ 16
	AR06 The physical and chemical processes involved in the phenomena of toxics, acid rain and long-range transport	11	AN15/ 93 SE06/ 108
Risk Management/ Criteria Development	AR07 Improved risk assessment capability	12	AN17/ 95 SE03/ 105 AR01/ 6
Sources/Inventories	AR08 Industrial/commercial emissions	13	LS03/ 62 AN16/ 94 SE02/ 104
	AR09 Stationary domestic sources	14	
	AR10 Mobile sources	15	SE02/ 104
Instrument Development and Application	AR11 Monitoring capability for air pollutants	16	WA04/ 27 WA07/ 30 LS03/ 62 LS13/ 72 AN16/ 94

RESEARCH CATEGORY	ISSUES	PAGE NUMBER	RELATED ISSUES AND PAGE NO.
Control and Remedial Technology	AR12 New control technology, devices and processes	17	SE02/ 104 SE04/ 106
	AR13 Remedial measures due to air pollution effects	18	SE02/ 104

AIR QUALITY RESEARCH: CONTAMINANT EFFECTS/TOXICOLOGY/FATES

ISSUE: AR01

The effects of air pollution on human beings.

Type of Research Needed:*

- Evaluation of acute and chronic effects of toxic or conventional pollutants (single or multiple) on human health.
- Determination of the effects of non-ionizing radiation on humans.
- Determination of the relationship of noise, vibration and odour levels to quality of life.
- Determination of the relationship between ambient and source monitoring data, human health and various specific air pollution problems.
- Investigation of volatilization and effects on workers at industrial and municipal waste water treatment plants or industrial complexes.

***See Also:**

Socio-Economic Research: Environmental Damages and Benefits
- SE01

Air Quality Research: Risk Management 1 Criteria Development
- AR07

AIR QUALITY RESEARCH: CONTAMINANT EFFECTS/TOXICOLOGY/FATES

ISSUE: AR02

The impact of air pollution on eco-systems.

Type of Research Needed:*

- Studies of the accumulation and environmental pathways of toxic substances with particular reference to the Great Lakes Basin; e.g., atmospheric-terrestrial and aquatic interactions as they relate to movement and fate of toxic substances in environmental media.
- Investigation of impact of Sulphur and Nitrogen based acids from the atmosphere due to Long Range Transport of Air Pollutants.
- Determination of which air contaminants are having direct or indirect impact on animal life.
- Development/screening of invertebrates for biological indicators of environmental contaminants.
- Assessment of the accumulation and environmental pathways of toxic substances near point, area and mobile sources (e.g., near major traffic arteries or in areas with considerable wood burning activity).

*See Also:

Water Quality Research:	Impact of Pollutant Discharges on Aquatic Systems
	- WA20
Socio-Economic Research:	Environmental Damages and Benefits
	- SE01

AIR QUALITY RESEARCH: CONTAMINANT EFFECTS/TOXICOLOGY/FATES

ISSUE: AR03

Phytotoxicology in identifying and quantifying the effects of air pollutants.

Type of Research Needed:*

- Determination of the physiological pathways by which pollutants enter plants.
- Study of the interaction between plant diseases and various pollutants to determine the important parameters which affect the response of the plant.
- Systematic sampling of vegetation to determine the background concentrations of organic and inorganic compounds.
- Examination of the concept of pollutant flux into crop and forest canopies and to determine how agrometeorological factors affect pollutant uptake by vegetation.
- Assessment of the effect of accumulation of various pollutants on vegetation.
- Determination of the optimum, critical, and toxic concentration of various elements in the soil in forms available to plant (especially forest species) roots.
- Development of vegetation monitors for environmental contaminants of interest.

*See Also:

Water Quality Research: Contaminant Fate and Transport Processes
in Aquatic Systems
- WA15
Socio-Economic Research: Environmental Damages and Benefits
- SE01

AIR QUALITY RESEARCH: ATMOSPHERIC PROCESSES (including
Source-Receptor Links)

ISSUE: AR04

Atmospheric dispersion of air emissions.

Type of Research Needed:*

- Modelling and field studies of dispersion from non-standard sources (e.g. mine tailings, fugitive emissions).
- Physical modelling of stable atmospheric dispersion.
- Modelling of concentration fluctuations; e.g. odours.
- Study of the quantification of boundary layer turbulence.
- Development of meteorological instruments for boundary layer turbulence characterization.
- Study of building wake dispersion.

***See Also:**

Water Quality Research:	Managing Non-point Sources of Pollution - WA10
Water Quality Research:	Contaminant Fate and Transport Processes in Aquatic Systems - WA19
Liquid & Solid Waste Research:	Waste Handling - LS03
Socio-Economic Research:	Costs of Controls and Mitigation - SE02
Socio-Economic Research:	Enviro-Economic Modelling - SE06

AIR QUALITY RESEARCH: ATMOSPHERIC PROCESSES (including
Source-Receptor Links)

ISSUE: AR05

Improved emergency response capability.

Type of Research Needed: *

- Improvement of the methods for calculating toxic compound concentrations downwind of emergency sites.

*See Also:

Air Quality Research: Instrument Development and Application
- AR11

AIR QUALITY RESEARCH: ATMOSPHERIC PROCESSES (including
Source-Receptor Links)

ISSUE: AR06

The physical and chemical processes involved in the phenomena of toxics, acid rain and long range transport.

Type of Research Needed:*

- Studies of the atmospheric deposition and transformation of substances involved in the acid rain problem and other pollutant studies.
- Refinement of long range and meso-scale atmospheric transport modelling including physical modelling of heavy gas dispersion in a complex urban setting.
- Determination of the deposition mechanisms of airborne compounds.
- Parameterization of cumulus clouds in long range transport models.
- Development and evaluation of atmospheric deposition monitoring equipment.
- Derivation of new methods to quantify air quality and long range transport of pollutants in Ontario.
- Development of techniques suitable for routine, monitoring in remote areas of Ontario.

*See Also:

Analytical Method Development: Air and Water Analysis

- AN15

Socio Economic Research: Enviro-Economic Modelling

- SE06

AIR QUALITY RESEARCH: RISK MANAGEMENT/CRITERIA DEVELOPMENT

ISSUE: AR07

Improved risk assessment capability.

Type of Research Needed: *

- Development of better risk assessment techniques for air quality protection.
- Determination of the risk due to specific airborne contaminants.
- Provision of sufficient information to establish exposure standards (including socio-economic studies).

See Also:

Analytical Method Development:	Biological Analysis
	- AN17
Socio-Economic Research:	Evaluation Tools and Applications
	- SE03
Air Quality Research:	Contaminant Effects/Toxicology/ Fates
	- AR01

AIR QUALITY RESEARCH: SOURCES/INVENTORIES

ISSUE: AR08

Industrial/commercial emissions.

Type of Research Needed:*

- Identification and quantification of emissions (e.g. source measurements and inventory emissions methodology development) of PCDF, PCCD, PAH, PCB, pesticides, trace metals, etc. from various area and point sources.
- Development of inexpensive stack samplers and sampling techniques which can be quickly put in place.

*See Also:

Liquid & Solid Waste Research: Waste Handling

- LS03

Analytical Method Development: Air Analysis

- AN16

Socio-Economic Research:

Costs of Controls and Mitigation

- SE02

AIR QUALITY RESEARCH: SOURCES/INVENTORIES

ISSUE: AR09

Stationary domestic sources.

Type of Research Needed:

- Determination of the quality and significance of residential burning of solid fuels on air and precipitation quality.

AIR QUALITY RESEARCH: SOURCES/INVENTORIES

ISSUE: AR10

Mobile sources.

Type of Research Needed:*

- Identification and quantification of individual organic compounds and trace metals in the exhaust of internal combustion engines.
- Determination of the effect of increasing fuel volatility in gasoline.

*See Also:

Socio-Economic Research: Costs of Controls and Mitigation
- SE02

AIR QUALITY RESEARCH: INSTRUMENT DEVELOPMENT AND APPLICATION

ISSUE: AR11

Monitoring capability for air pollutants.

Type of Research Needed:*

- Development of monitors for toxic substances.
- Development of source and ambient sampling methods for semi-volatile toxics e.g. PAH, PCDD, pesticides, etc.
- Study of high resolution and multidimensional (high resolution) GC and development of a data base for mobile monitoring of organic compounds.
- Determination of the monitoring capabilities required to adequately assess human exposure to air pollutants.
- Development of measurement methods for arsenic and other volatile metals and organometallics.
- Development of calibration standards for trace organic compounds and procedures for field calibration of complex mixtures.
- Study of the ion chemistry of CI/MS and CI/MS/MS and development of the data base for organic compounds specific to APCI source (required for application to TAGAs).
- Study of high resolution and multidimensional (high resolution) GC in connection with EI-MS and FTIR and development and expansion of the appropriate data base for real time mobile monitoring.
- Development of monitoring methodologies and equipment for odorous compounds.
- Development of sampling techniques and protocols for air pollutants with appropriate instrumentation and integration with appropriate analyzers.
- Development of monitors (both continuous and remote sensing) for common pollutants.
- Development of portable reliable field monitors and samplers for specific contaminants.

***See Also:**

Water Quality Research:	Industrial Wastewater Treatment
	- WA04
Water Quality Research:	Municipal Wastewater Treatment
	- WA07
Liquid and Solid Waste Research:	Waste Handling
	- LS03
Liquid and Solid Waste Research:	Landfill Technology
	- LS13
Analytical Method Development:	Air Analysis
	- AN16

AIR QUALITY RESEARCH: CONTROL AND REMEDIAL TECHNOLOGY

ISSUE: AR12

New control technology, devices and processes.

Type of Research Needed:*

- Development of accurate, unbiased assessment techniques for new control technologies for atmospheric contaminants of major concern in Ontario.
- Development of new control processes to control air emissions such that the contamination problem is not transferred to another medium creating additional problems such as solid waste disposal.

*See Also:

Socio-Economic Research: Costs of Controls and Mitigation
- SE02

Socio-Economic Research: Environmental Protection Industry
- SE04

AIR QUALITY RESEARCH: CONTROL AND REMEDIAL TECHNOLOGY

ISSUE: AR13

Remedial measures due to air pollution effects.

Type of Research Needed:*

- Development of alternatives to removal of contaminated soil.
- Development of techniques for revegetating alkaline and/or saline soil.

*See Also:

Socio-Economic Research: Costs of Controls and Mitigation
- SE02

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WATER QUALITY RESEARCH NEEDS

WATER QUALITY RESEARCH

Research needs related to water and the aquatic environment cover a broad range of concerns and issues. The needs identified hereafter reflect the Ministry's interests in establishing improved treatment processes for the Province's drinking water supplies and the removal or neutralization of municipal, industrial and diffuse source wastes, developing a better understanding of cause-effect relationships in aquatic systems so that effort can be directed to deal more effectively with water quality impacts, and determining improved environmental evaluation techniques.

For convenience, water research requirements have been grouped into the following eight categories, involving 33 issues and about 130 specific needs:

- 1) Industrial Wastewater Treatment
- 2) Municipal Wastewater Treatment
- 3) Managing Non-Point Sources of Pollution
- 4) Contaminant Fate and Transport Processes in Aquatic Systems
- 5) Impacts of Pollutant Discharges on Aquatic Systems
- 6) Drinking Water
- 7) Effects of Acidic Deposition and Long Range Transport of Contaminants
- 8) Other

Much has been accomplished in 1988/89 and the research issues and specific needs have been adjusted for fiscal year 1989-90 based on input from head office and regional staff throughout the Ministry. New issues include WA10 to investigate effects of intensive crop production practices on groundwater quality, WA14 to identify remedial measures to minimize the impact of lakeshore development, WA15 dealing with the aquatic effects of timber management practices, WA18 involving the development of models to address contaminant fate and transport in the Great Lakes, WA21 to model the impacts of contaminant discharges on aquatic biota, WA30 on the distribution, behaviour and effects of low level trace metals in aquatic systems, WA31 concerning the effects of organic contaminants associated with long range transport and finally, WA33 dealing with the spatial analyses of water quality.

Clearly, the Ministry's top priority in water research relates to evaluations of the significance of hazardous contaminants and minimization of these contaminants as a threat to our natural waters and drinking water supplies. This emphasis is reflected by the vast majority of the 33 research issues and related needs that have been identified. Studies carried out by universities and private sector consultants within the Ministry's environmental research program provide a substantial information base that contributes to the formulation of effective legislation, policies and workable solutions for resolving the numerous problems and concerns presented by hazardous contaminants in our aquatic ecosystem.

SUMMARY OF WATER QUALITY RESEARCH ISSUES

RESEARCH CATEGORY	ISSUES	PAGE NUMBER	RELATED ISSUES AND PAGE NO.
<u>WATER QUALITY RESEARCH</u>			
Industrial Wastewater Treatment	WA01 Efficiencies of selected conventional and advanced wastewater treatment systems currently used in the Ontario pulp and paper, steel and petroleum/ petrochemical industry	24	AN11/ 89 AN17/ 95 SE02/ 104
	WA02 Efficiencies of selected conventional and advanced wastewater treatment systems used by industrial concerns discharging wastes to municipal sewer systems	25	AN11/ 89 SE02/ 104
	WA03 Hazardous chemicals in sewer systems and their treatment	26	SE02/ 104
	WA04 Emerging technologies for industrial process changes to reduce contaminant loadings to waste streams	27	AR11/ 16 LS02 61 SE02/ 104 SE03/ 105
Municipal Wastewater Treatment	WA05 Fate and removability of hazardous compounds in municipal water pollution control plants	28	AN11/ 89
	WA06 Innovative sewage treatment process research	29	AR12/ 17 SE02/ 104
	WA07 Compliance and monitoring tools	30	AR11/ 16 AN08/ 86 SE03/ 105
Managing Non-Point Sources of Pollution	WA08 Natural occurrence of some organic and inorganic contaminants in surface and groundwaters	31	AN15/ 93
	WA09 Impacts of agricultural tile drainage on receiving watercourses	32	

RESEARCH CATEGORY	ISSUES	PAGE NUMBER	RELATED ISSUES AND PAGE NO.
Managing Non-Point Sources of Pollution (continued)	WA10 Effects of intensive crop production practises on groundwater quality	33	SE02/ 104
	WA11 Pesticide/herbicide residues in tributaries	34	SE03/ 105
	WA12 Uncertainty in nutrient/ contaminant loadings and the projected impact on the Great Lakes	35	
	WA13 Remedial measures to minimize the impact of agricultural practices on water quality	36	SE02/ 104
	WA14 Remedial measures to minimize the impact of lakeshore development	37	SE02/ 104
	WA15 Effects of timber manage- ment practices on water quality	38	
	WA16 Hazardous contaminants in combined sewage overflows (CSO) and stormwater runoffs (SWR) and development of optimal control options	39	
Contaminant Fate and Transport Processes in Aquatic Systems	WA17 Persistence, migration and breakdown processes of selected hazardous contaminants in soil and groundwater	40	AR03/ 8 LS15/ 74 AN15/ 93
	WA18 Modelling contaminant fate and transport in aquatic systems	41	
	WA19 Fate and pathways of in-stream pollutants associated with suspended sediments	42	

RESEARCH CATEGORY	ISSUES	PAGE NUMBER	RELATED ISSUES AND PAGE NO.
Impacts of Pollutant Discharges on Aquatic Systems	WA20 Biological responses to contamination from industrial and municipal discharges	43	AR02/ 7 AN11/ 89 AN17/ 95 SE01/ 102
	WA21 Modelling impacts of contaminant discharges on aquatic biota	44	SE06/ 108
	WA22 Aquatic macrophyte and algal responses to anthropogenic and other controlling factors and the role of aquatic plants in nutrient and contaminant cycling in the aquatic environment	45	
	WA23 Statistical significance in contaminant sampling	46	SE03/ 105
	WA24 Impacts of in-place pollutants in sediments on the aquatic ecosystem and human health	47	AN17/ 95 SE01/ 102 SE02/ 104
	WA25 Impact of organic compounds in pulp and paper discharges on aquatic life and fish consumption by humans	48	AN01/ 79 AN17/ 95 SE01/ 102
	WA26 Removal capabilities of treatment techniques for specific trace contaminants in drinking water	49	SE03/ 105
Drinking Water	WA27 Drinking water quality objectives and treatment processes	50	
	WA28 Nitrate contamination of aquifers in relation to future development of individual and/or communal groundwater supplies	51	

RESEARCH CATEGORY	ISSUES	PAGE NUMBER	RELATED ISSUES AND PAGE NO.
Effects of Acidic Deposition and the Long Range Transport of Contaminants	WA29 Effects of acidification on biota	52	AR02/ 7 SE06/ 108
	WA30 Distribution, behaviour and effects of low level trace metals in aquatic systems	53	AR02/ 7 AR06/ 11
	WA31 Effects of organic contaminants associated with long range transport	54	AR02/ 7
	WA32 Paucity of epidemiological information relating pathogens and hazardous contaminants and their effects on humans and other animals	55	SE01/ 102
Other	WA33 Spatial analysis of water quality	56	SE02/ 105 SE06/ 108

WATER QUALITY RESEARCH: INDUSTRIAL WASTEWATER TREATMENT

ISSUE: WAO1

Efficiencies of selected conventional and advanced wastewater treatment systems currently used in the Ontario pulp and paper, steel and petroleum/petrochemical industry.

Type of Research Needed:*

- Establishment and testing of the usefulness of surrogate chemical parameters for monitoring chlorinated organics in pulp and paper mill effluents.
- Development and assessment of Best Management Practices.
- Evaluation of toxicity to fish and other aquatic organisms and taste and odour/tainting potential of influent and effluent streams and identification of probable associations/correlations of these effects with the contaminants (and their levels) found.
- Comparison of removal efficiencies of different systems and identification of the major design and operating factors influencing removal.

***See Also:**

Analytical Method Development: Drinking, Surface, Wastewater Analysis

- **AN11**

Analytical Method Development: Biological Analysis

- **AN17**

Socio-Economic Research: Costs of Controls and Mitigation

- **SE02**

WATER QUALITY RESEARCH: INDUSTRIAL WASTEWATER TREATMENT

ISSUE: WA02

Efficiencies of selected conventional and advanced wastewater treatment systems used by industrial concerns discharging wastes to municipal sewer systems.

Type of Research Needed:*

- Comparison of removal efficiencies of different systems and identification of major design and operating factors influencing removal for the following sectors:
 - organic chemicals sector
 - printing and publishing sector
 - electrical and mechanical equipment sector
 - waste recycling sector (including solvent, drum, oil, battery and metal recyclers)
 - food and kindred products sector
 - manufacturing sector
 - services sector.
- Development and assessment of Best Management Practices.

***See Also:**

Analytical Method Development: Drinking, Surface, Wastewater Analysis

- AN11

Socio-Economic Research: Costs of Controls and Mitigation

- SE02

WATER QUALITY RESEARCH: INDUSTRIAL WASTEWATER TREATMENT

ISSUE: WA03

Hazardous chemicals in sewer systems and their treatment.

Type of Research Needed:*

- Study of the fate and transport of volatile organic compounds in sewer systems.
- Study of the fate and transport of odour compounds in sewer systems.
- Development and assessment of technology for the control of volatile organics and odour compounds in sewer systems, pumping stations and the headworks of STP.

***See Also:**

Socio-Economic Research: Costs of Control and Mitigation
- SE02

WATER QUALITY RESEARCH: INDUSTRIAL WASTEWATER TREATMENT

ISSUE: WA04

Emerging technologies for industrial process changes to reduce contaminant loading to waste streams.

Type of Research Needed: *

- Assessment of industrial processes to reduce toxic loadings to wastewater streams (eg. replacement of chlorine with oxygen delignification in pulp bleacheries).
- Evaluation of methods of spill control and of inplant treatment to reduce contaminant loading to waste streams.

*See Also:

Air Quality Research:

Instrument Development and Application

- AR11

Liquid and Solid Waste Research :

Waste Handling

- LS02

Socio-Economic Research:

Costs of Controls and Mitigation

- SE02

Socio-Economic Research:

Evaluation Tools and Applications

- SE03

WATER QUALITY RESEARCH: MUNICIPAL WASTEWATER TREATMENT

ISSUE: WA05

Fate and removability of hazardous compounds in municipal water pollution control plants.

Type of Research Needed: *

- Identification and use of surrogate compounds to determine fate and treatability of other compounds.
- Assessment of the fate, removability and stability of hazardous contaminants during and after sludge treatment.
- Grouping of hazardous substances using Quantitative Structure Activity Relationships (QSAR) or other techniques to categorize and reduce priority pollutant lists.
- Development of a method to predict the biodegradability of trace organic contaminants in municipal wastewater treatment systems.

***See Also:**

Analytical Method Development: Drinking, Surface, Wastewater Analysis
- AN11

WATER QUALITY RESEARCH: MUNICIPAL WASTEWATER TREATMENT

ISSUE: WA06

Innovative sewage treatment processes.

Type of Research Needed: *

- Assessment of the sequencing batch reactor, biological phosphorus removal and integrated sewage treatment and energy production plants.
- Assessment of bio-augmentation and bio-stimulation processes to improve the removal of organic contaminants by municipal STP, and their ability to withstand organic shock loads.
- Assessment of mixed biological/activated carbon process to improve hazardous contaminants removal.

***See Also:**

Air Quality Research:	Assessment of New Control Technology, Devices and Processes
	- AR12
Socio-Economic Research:	Costs and Controls of Mitigation
	- SE02

WATER QUALITY RESEARCH: MUNICIPAL WASTEWATER TREATMENT

ISSUE: WA07

Compliance and monitoring tools.

Type of Research Needed:*

- Development of innovative techniques and mechanisms to effectively monitor, identify (in field) and determine the source of a hazardous contaminant discharge from industrial, commercial or institutional premises.
- Assessment of on-site effluent toxicity measurement procedures.
- Development of statistically valid sampling strategies to assist in the assessment of chemicals of concern from the MISA EMPPL.

***See Also:**

Air Quality Research:	Instrument Development and Application
	- AR11
Analytical Method Development:	Drinking, Surface, Wastewater Analysis
	- AN08
Socio-Economic Research:	Evaluation Tools and Applications
	- SE03

WATER QUALITY RESEARCH: MANAGING NON-POINT SOURCES OF POLLUTION

ISSUE: WA08

Natural occurrence of some organic and inorganic contaminants in surface and ground waters.

Type of Research Needed:*

- Determination of sources, availability and significance of trace metals, fluoride, aromatics, radon from specific geological formations, (e.g. limestone, igneous rocks, oil-bearing shales).
- Evaluation of the significance of substances (eg. phenols) produced by the decay of vegetation on aquatic life (tainting, toxicity).
- Development of concepts of ecoregion, surface water classification schemes and attainable water quality.

*See Also:

Analytical Method Development: Air and Water Analysis
- AN15

WATER QUALITY RESEARCH: MANAGING NON-POINT SOURCES OF POLLUTION

ISSUE: WA09

Impacts of agricultural tile drainage on receiving watercourses.

Type of Research Needed:

- Evaluation of nutrients and solids transport under varying cropping and tillage conditions.
- Study of the effects of tile drainage and open ditches on peak flows and dry weather flows.
- Evaluation of tile drainage on removal of nutrient and pesticide residues.

WATER QUALITY RESEARCH: MANAGING NON-POINT SOURCES OF POLLUTION

ISSUE: WA10

Effects of intensive crop production practices on groundwater quality.

Type of Research Needed: *

- Investigation of the relationship between cropping practice and groundwater contamination by pesticides.
- Investigation of relationships between crop production and fertilization practices and groundwater quality.

*See Also:

Socio-Economic Research: Costs and Controls of Mitigation
- SE02

WATER QUALITY RESEARCH: MANAGING NON-POINT SOURCES OF POLLUTION

ISSUE: WA11

Pesticide/herbicide residues in tributaries.

Type of Research Needed: *

- Assessment of frequency and trends in detections of pesticides/herbicides in water, sediment and biota of selected tributaries (Grand/Saugeen/Thames).
- Development of a screening model to evaluate likely management scenarios.

*See Also:

Socio-Economic Research: Evaluation tools and applications
- SE03

WATER QUALITY RESEARCH: MANAGING NON-POINT SOURCES OF POLLUTION

ISSUE: WA12

Uncertainty in nutrient/contaminant loadings and the projected impact on the Great Lakes.

Type of Research Needed:

- Stochastic analysis of ambient water quality data.
- Assessment of impact of uncertainty in long-term phosphorus loadings to Great Lakes phosphorus mass balances.
- Development of methods to better quantify low level contaminant loadings.
- Assessment of reliability and trends in loadup in Ontario tributaries.

WATER QUALITY RESEARCH: MANAGING NON-POINT SOURCES OF POLLUTION

ISSUE: WA13

Remedial measures to minimize the impact of agricultural practices on water quality.

Type of Research Needed: *

- Development of domestic and dairy waste treatment systems which function well in poorly drained soils.
- Documentation of the impact of vegetative buffer strips adjacent to streams and municipal drains on water quality.

*See Also:

Socio-Economic Research: Costs of Controls and Mitigation
- SE02

WATER QUALITY RESEARCH: MANAGING NON-POINT SOURCES OF POLLUTION

ISSUE: WA14

Remedial measures to minimize the impact of lakeshore development.

Type of Research Needed: *

- Evaluation of efficacy of vegetative buffer strips at reducing nutrient inputs from lakeshore development on Canadian Shield lakes
- Development of efficient monitoring techniques for rapid evaluation of trophic status/chemistry of lakes

*See Also:

Socio-Economic Research: Costs of Controls and Mitigation
- SE02

WATER QUALITY RESEARCH: MANAGING NON-POINT SOURCES OF POLLUTION

ISSUE: WA15

Effects of timber management practices on water quality.

Type of Research Needed:

- Evaluation of effects of access road construction on water quality (especially suspended solids and nutrients) and biota of streams and lakes in Ontario boreal forests.
- Evaluation of various timber harvest practices on water quality and biota of streams and lakes in Ontario boreal forests.

WATER QUALITY RESEARCH: MANAGING NON-POINT SOURCES OF POLLUTION

ISSUE: WA16

Hazardous contaminants in combined sewage overflows (CSO) and stormwater runoff (SWR) and development of optimal control options.

Type of Research Needed:

- Definition of the relationship between land-use patterns (i.e. industrial, residential and commercial uses) and the type and concentrations of hazardous contaminants in CSO and SWR.
- Definition of the distribution of hazardous contaminants between settleable and non-settleable solids plus liquid phases in CSO and SWR.
- Definition of the relationship between concentrations of hazardous contaminants in CSO and duration of overflows (i.e. the hydrographs).
- Determination of the rate of accumulation of hazardous contaminants on urban land surfaces.
- Investigation of the removability of selected hazardous contaminants in CSO and SWR by conventional means (e.g. solids removal and/or street sweeping).
- Derivation of innovative techniques and mechanisms to effectively monitor and control hazardous contaminant discharges into sewer systems.
- Evaluation of innovative techniques to remove or fix contaminants in surface water runoff.

WATER QUALITY RESEARCH: CONTAMINANT FATE AND TRANSPORT
PROCESSES IN AQUATIC SYSTEMS

ISSUE: WA17

Persistence, migration and breakdown processes of selected hazardous contaminants in soil and groundwater.

Type of Research Needed: *

- Laboratory and field tests of half-life and migration of hazardous contaminants in the various soil and groundwater conditions found in Ontario.
- Determination of the additive effects of substances in a mixture on mobility of a given contaminant due to the presence of solvents.

***See Also:**

Air Quality Research:	Contaminant Effects/Toxicity/Fates
	- AR03
Liquid and Solid Waste Research:	Groundwater Contamination
	- LS15
Analytical Methods Development:	Air and Water Analysis
	- AN15

WATER QUALITY RESEARCH: CONTAMINANT FATE AND TRANSPORT
 PROCESSES IN AQUATIC SYSTEMS

ISSUE: WA18

Modelling contaminant fate and transport in aquatic systems.

Type of Research Needed:

- Prediction of currents from wind data at Great Lake nearshore locations where no current meters have been operated.
- Development of a numerical model to predict the extent and water quality of a river plume where it merges into a lake.
- Development of a numerical model to predict the hydrodynamics of the whole lake and then focus on a local area for better resolution.
- Development of computer simulations of dispersion patterns of nearfield and farfield discharges in the Great Lakes in order to define fate and transport of bacteria, organic and inorganic compounds.
- Development of models for the fate and biological uptake of contaminants with high Kow.
- Development of predictive models to identify depositional areas and areas of resuspension and transport in streams and the nearshore zone of the Great Lakes.
- Measurement and modelling of sediment resuspension and redistribution due to wave action, storms and currents.
- Development of models to address mine tailing discharge assimilation.

WATER QUALITY RESEARCH: CONTAMINANT FATE AND TRANSPORT
 PROCESSES IN AQUATIC SYSTEMS

ISSUE: WA19

Fate and pathways of in-stream pollutants associated with suspended sediments.

Type of Research Needed:

- Investigation of the relationships between metal levels in suspended sediment, their geochemical distribution and factors that influence them (pH, hardness).
- Investigation of the contribution of sediment entrainment in rivers to bacterial levels.
- Investigation of the relationship between suspended sediments and organic contaminant levels.

WATER QUALITY RESEARCH: IMPACTS OF POLLUTANT DISCHARGES ON
AQUATIC SYSTEMS

ISSUE: WA20

Biological responses to contamination from industrial and municipal discharges.

Type of Research Needed: *

- Development of routine procedures for measurement of biochemical and physiological stress in organisms exposed to contaminants.
- Development of mutagenic and carcinogenic test systems related to aquatic organisms.
- Evaluation of the significance of elevated levels of heavy metals and organic compounds on the growth and reproductive success of aquatic organisms.
- Assessment of the importance of modifying factors (hardness, pH, temperature) on the toxicity and bioavailability of metals and other substances.
- Significance (short and long term) of recent increases in nitrogen levels in Great Lakes and tributary waters.
- Evaluation of responses to decreasing phosphorus levels in the Great Lakes system.
- Development of surrogates for rapid and effective monitoring of hazardous waste discharges.
- Evaluation of the effects of bioaccumulated organics and metals on the health of aquatic organisms at various levels in the food chain, leading to development of guidelines for biological organisms.
- Evaluation of the significance of contaminant uptake via ingestion vs uptake directly from water?

***See Also:**

Air Quality Research:	Contaminant Effects/Toxicity/Fate - AR02
Analytical Method Development:	Drinking, Surface, Wastewater Analysis - AN11
Analytical Method Development:	Biological Analysis - AN17
Socio-Economic Research:	Environmental Damages and Benefits - SE01

WATER QUALITY RESEARCH: IMPACTS OF POLLUTANT DISCHARGES ON
AQUATIC SYSTEMS

ISSUE: WA21

Modelling impacts of contaminant discharges on aquatic biota.

Type of Research Needed: *

- Development of a dynamic site and species specific model for representing the impact of a proposed contaminant load on the aquatic biota
- Determination of the usefulness of the concept of "size classification" on pelagic and benthic food chain models.
- Development of procedures for modelling the toxic effects of mixtures of chemicals found in effluents.

***See Also:**

Socio-Economic Research: Enviro-Economic Modelling
 - SE06

WATER QUALITY RESEARCH: IMPACTS OF POLLUTANT DISCHARGES ON
AQUATIC SYSTEMS

ISSUE: WA22

Aquatic macrophyte and algal responses to anthropogenic and other controlling factors and the role of aquatic plants in nutrient and contaminant cycling in the aquatic environment.

Type of Research Needed:

- Determination of shading effects of phytoplankton on macrophyte growth in nutrient rich lakes.
- Assessment of year-to-year variability of Dicotomosiphon growth and distribution in Lake Simcoe and determination of light requirements for this benthic alga.
- Development of methods of control of potentially toxic blue-green algae through phosphorus reduction or nitrogen manipulation.
- Identification of factors affecting metal accumulation in filamentous algae in Georgian Bay and softwater lakes and the significance and fate of metals subject to bioaccumulation.
- Assessment of relationship between acidity and phosphorus utilization in acidic lakes, including phosphatase activity, herbivore effects and light, pH and inorganic carbon requirements.
- Development of simple techniques for identifying species and forms based on electrophoretic/enzymatic procedures.

WATER QUALITY RESEARCH: IMPACTS OF POLLUTANT DISCHARGES ON
 AQUATIC SYSTEMS

ISSUE: WA23

Statistical significance in contaminant sampling.

Type of Research Needed*

- Development of valid sampling design for identifying non-compliance with Provincial Water Quality Objectives in areas of impact.
- Development of procedures for optimizing sampling frequency for determining contaminant loadings for point source discharges and total contaminant loads to lake basins (e.g. Lake Ontario).
- Development of procedures for comparing recent data with historical data when the detection limit has changed.
- Development of QA/QC procedures for field sampling programs.
- Development of procedures for comparing sediment samples with different proportions of various grain sizes.

***See Also:**

Socio-Economic Research:

Evaluation Tools and Applications
- SE03

WATER QUALITY RESEARCH: IMPACTS OF POLLUTANT DISCHARGES ON
AQUATIC SYSTEMS

ISSUE: WA24

Impacts of in-place pollutants in sediments on the aquatic ecosystem and human health.

Type of Research Needed: *

- Measurements of uptake by and release from sediments of trace substances.
- Assessment of transformations of trace organics and inorganics in sediments.
- Determination of availability of trace organics and heavy metals in sediments and suspended sediments to biota.
- Evaluation of background quality of native soils in Southern Ontario and implications for lakefill quality and dredgate disposal guidelines.
- Development of immobilization techniques such as chemical fixation, overlaying with clean segment.
- Assessment of effectiveness of alternate approaches to isolating, removing, treating and/or disposing of contaminated sediments.
- Evaluation and case histories of "natural" restoration processes (eg. Hg - English Wabigoon, St. Clair River).
- Development of simple, reliable, laboratory based techniques to evaluate the potential impacts of in-place pollutants on the aquatic ecosystem.
- Determination of significance of suspended solids on fish health (gill clogging, feeding behaviour etc.).

***See Also:**

Analytical Method Development:	Biological Analysis
	- AN17
Socio-Economic Research:	Environmental Damages and Benefits
	- SE01
Socio-Economic Research:	Costs of Controls and Mitigation
	- SE02

WATER QUALITY RESEARCH: IMPACTS OF POLLUTANT DISCHARGES ON
 AQUATIC SYSTEMS

ISSUE: WA25

Impact of organic compounds in pulp and paper discharges on aquatic life and fish consumption by humans.

Type of Research Needed: *

- Studies of toxicity, uptake and depuration rate relative to industrial and in-place pollutants.
- Identification of tainting compounds.
- Development of rapid, selective testing procedures for the analysis of trace organics in pulp and paper effluents for chemicals specific to the industry followed by assessment of effects on aquatic life.
- Identification and quantification of compounds of significance.

***See Also:**

- | | |
|--------------------------------|-------------------------------------|
| Analytical Method Development: | Refinement of Analytical Techniques |
| | - AN01 |
| Analytical Method Development: | Biological Analysis |
| | - AN17 |
| Socio-Economic Research: | Environmental Damages and Benefits |
| | - SE01 |

WATER QUALITY RESEARCH: DRINKING WATER

ISSUE: WA26

Removal capabilities of treatment techniques for specific trace contaminants in drinking water.

Type of Research Needed: *

- Evaluation of the effectiveness of innovative treatment techniques (such as resin adsorption, reverse osmosis, aeration, biological filtration, GAC, PAC, ozonation and treatment train modifications) for hazardous contaminant removal.
- Development of protocols for the assessment of treatment methodologies for groups of compounds and specific trace contaminants.
- Development of a computer assisted treatment process choice for use as a decision making framework for the removal/reduction of trace contaminants from drinking water.

***See Also:**

Socio-Economic Research: Evaluation Tools and Application
- SE03

WATER QUALITY RESEARCH: DRINKING WATER

ISSUE: WA27

Drinking water quality objectives and treatment processes.

Type of Research Needed:

- Provision of information required for the development of drinking water quality objectives for MOE list of priority chemicals.
- Assessment of use of mutagenicity testing in assessing drinking water treatment processes.
- Development of a means of predicting/establishing short-term variations in water quality at intakes and establishing subsequent treatment technology.
- Investigation of the by-products of the use of alternative treatment processes.
- Investigation of the production of additional contaminants in finished water because of the application of chlorine to water containing traces of contaminants (eg trichlorotoluene from water containing toluene).

WATER QUALITY RESEARCH: DRINKING WATER

ISSUE: WA28

Nitrate contamination of aquifers in relation to future development of individual and/or communal groundwater supplies.

Type of Research Needed:

- Study of the total nitrate loading on aquifers from septic system effluents, fertilizers and other potential sources.
- Study of the magnitude of seasonal nitrate level fluctuations in different aquifers (shallow and intermediate).
- Development of protocol to estimate total nitrate loading expected from proposed and existing development.
- Assessment of the need and feasibility of nitrate removal systems in communal systems and/or small private systems.
- Investigation of the use of nitrate as an indicator parameter for other potential contaminants, especially organics originating from septic effluents.

WATER QUALITY RESEARCH: EFFECTS OF ACIDIC DEPOSITION AND THE
LONG RANGE TRANSPORT OF CONTAMINANTS

ISSUE: WA29

Effects of acidification on biota.

Type of Research Needed: *

- Determination of the current extent of acidification impacts on sensitive biota.
- Determination of the extent and mechanisms responsible for the occurrence of spring mortality in populations of biota in soft water lakes.
- Determination of the effects of surface water acidification on biota in running water and a definition of mechanisms of population loss.

*See Also:

Air Quality Research:	Contaminant Effects/Toxicology/Fate
	- AR02
Socio-Economic Research:	Enviro-Economic Modelling
	- SE06

WATER QUALITY RESEARCH: EFFECTS OF ACIDIC DEPOSITION AND THE
LONG RANGE TRANSPORT OF ORGANICS

ISSUE: WA30

Distribution, behaviour and effects of low level trace metals in aquatic systems.

Type of Research Needed: *

- Assessment of mercury methylation/demethylation rates in oligotrophic softwater lakes and their watersheds.
- Development of empirical models to describe the partitioning of mercury and methyl mercury in watershed soils, streams and oligotrophic softwater lakes.
- Development of mathematical models of methyl mercury accumulation by aquatic biota to clarify the influence of acidification and the factors affecting uptake and elimination.
- Determination of the microorganisms responsible for mercury methylation/demethylation and the effect of acidification on these organisms.
- Determination of fate and transport of trace metals associated with atmospheric deposition in watershed soils, streams and softwater lakes.
- Evaluation of the uptake and chronic effects of trace metal levels (Pb, Cd, Cu, Zn) on aquatic biota.
- Determination of metal enrichment in waterfowl and their prey species.
- Determination of the mechanisms of metal enrichment of the food chain of acidified lakes.

***See Also:**

Air Quality Research:	Contaminant Effects/Toxicology/Fates
	- AR02
Air Quality Research:	Atmospheric Processes
	- AR06

WATER QUALITY RESEARCH: EFFECTS OF ACIDIC DEPOSITION AND THE
LONG RANGE TRANSPORT OF CONTAMINANTS

ISSUE: WA31

Effects of organic contaminants associated with long range transport.

Type of Research Needed:*

- Determination of extent and significance of bioaccumulation of organic contaminants associated with long range transport.
- Determination of the fate of organic contaminants associated with long range transport and the pathways of transport from the atmosphere through the terrestrial system and into the aquatic system.

*See Also:

Air Quality Research: Contaminant Effects/Toxicology/Fates
- AR02

WATER QUALITY RESEARCH: OTHER

ISSUE: WA32

Paucity of epidemiological information relating pathogens and hazardous contaminants and their effects on humans and other animals.

Type of Research Needed: *

- Determination of the resistance of specific pathogens to disinfection practices in drinking and waste water treatment plants.
- Determination of effective dose of major waterborne pathogens on humans.
- Definition of the significance/effects of photo-reactivation of indicator organisms and pathogens in surface waters which receive sewage effluent.
- Examination of strategies for improving the reporting of waterborne disease.
- Epidemiological studies to relate the effects of hazardous contaminants to humans.

*See Also:

Socio-Economic Research: Environmental Damages and Benefits
- SE01

WATER QUALITY RESEARCH: OTHER

ISSUE: WA33

Spatial analysis of water quality.

Type of Research Needed: *

- Development of statistical and mathematical water quality models for integration and analysis of spatial data bases within the context of Geographic Information Systems (GIS).
- Overlay and analysis of MOE water quality data bases (e.g. surface waters, groundwater, point source discharges, etc.), with related data bases, (e.g. geology, soils, ecosystem, land use, agricultural chemical usage, population, epidemiology, socioeconomic indicators, etc.), to ascertain statistical interrelationships on appropriate spatial scales.
- Development of spatial models for water quality management and policy development.

***See Also:**

Socio-Economic Research:	Evaluation Tools and Application
	- SE03
Socio-Economic Research:	Enviro-Economic Modelling
	- SE06

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LIQUID AND SOLID WASTE RESEARCH NEEDS

LIQUID AND SOLID WASTE RESEARCH

Research needs in the handling, treatment and disposal of liquid and solid wastes, not conveyed to municipal sewage treatment plants, are as diverse as the materials that make up the waste streams.

Future research needs, identified by the Ministry of the Environment, fall into one or more of three broad categories:

- Waste Handling
- Waste Reduction
- Landfill Technology

A total of fifteen general issues have been identified within these categories.

Our primary thrust is to reduce the amount of waste that must be treated or landfilled. Accordingly, there is a need for research into the "4R's" of waste management; the reduction, recycling, recovery and reuse of waste materials.

For those waste materials not encompassed by the 4R's program, characteristics should be determined so that the need for treatment and the required degree of treatment can be accurately identified. Having identified a need for some type of degree of treatment, it becomes necessary to develop and demonstrate the appropriate treatment methodologies.

Landfill sites will continue to be the ultimate repository of residual wastes, treated or untreated, and therefore it is a necessary requirement to investigate, improve and enhance landfill technology to ensure safe and aesthetically acceptable disposal of these wastes. This has been a major field of study in the past and continues to deserve attention. In particular, the control of contaminant migration from landfill sites and the safe containment of potentially dangerous wastes, including biomedical wastes and incinerator ash requires study as does site rehabilitation and remediation for existing sites.

SUMMARY OF LIQUID AND SOLID WASTE RESEARCH ISSUES

RESEARCH CATEGORY	ISSUES	PAGE NUMBER	RELATED ISSUES AND PAGE NO.
<u>LIQUID AND SOLID WASTE</u>			
Waste Handling	LS01 Characteristics of waste materials and the behaviour of wastes under various and varying conditions	60	AN01/ 79
	LS02 Methods and materials for the treatment of wastes and waste by-products	61	AR12/ 17 WA04/ 27 SE02/ 104
	LS03 Methods and materials for the destruction of wastes and waste by-products	62	AR04/ 9 AR08/ 13 AR11/ 16 AR12/ 17 AN14/ 92 AN16/ 94 SE02/ 104
	LS04 Methods for the ultimate disposal of wastes and waste by-products	63	SE02/ 104
Waste Reduction	LS05 Ways and means of reducing the volumes and contaminated mass of waste streams	64	SE02/ 104 SE03/ 105
	LS06 Ways and means of recycling materials currently in the waste stream	65	SE02/ 104 SE03/ 105
	LS07 Ways and means of recovering usable materials currently in the waste stream	66	SE02/ 104 SE03/ 105 SE04/ 106
	LS08 Ways and means of re-using materials diverted from current waste streams	67	SE02/ 104 SE03/ 105 SE04/ 106

RESEARCH CATEGORY	ISSUES	PAGE NUMBER	RELATED ISSUES AND PAGE NO.
Landfill Technology	LS09 Wastes and types of wastes being landfilled	68	AN14/ 92 SE02/ 104
	LS10 Methods, materials and performance of landfill covers	69	
	LS11 Methods, materials and performance of landfill liners	70	
	LS12 Characteristics and impacts of landfill leachate	71	AN14/ 92
	LS13 Production, control, collection and disposal of landfill gas	72	AR11/ 16 SE01/ 102
	LS14 End-use of closed landfills	73	
	LS15 Groundwater contamination from landfills	74	WA17/ 40 AN13/ 91 AN15/ 93

LIQUID AND SOLID WASTE RESEARCH: WASTE HANDLING

ISSUE: LS01

Characteristics of waste materials and the behaviour of wastes under various and varying conditions.

Type of Research Needed: *

- Determination of "inert" wastes.
- Determination of the long term effects of wastes.
- Studies on toxic hazardous waste materials including:
 - Assessment of existing hazardous waste schedules,
 - development of criteria for listing of hazardous waste based on toxicological studies (chronic and acute toxicity, persistence, bioaccumulation, leachability, etc.).
- Development of test criteria to define waste characteristics.

*See Also:

Analytical Method Development: Refinement of Analytical
Techniques
- AN01

LIQUID AND SOLID WASTE RESEARCH: WASTE HANDLING

ISSUE: LS02

Methods and materials for the treatment of wastes and waste by-products.

Type of Research Needed:*

- Investigation of biological, chemical and physical treatment processes for solid and liquid wastes.
- Investigation of methods for solidification and/or encapsulation.
- Investigation of disposal methods for treatment process effluents.

*See Also:

Air Quality Research:	Control and Remedial Technology
	- AR12
Water Quality Research:	Industrial Wastewater Treatment
	- WA04
Socio-Economic Research:	Costs of Controls and Mitigation
	- SE02

LIQUID AND SOLID WASTE RESEARCH: WASTE HANDLING

ISSUE: LS03

Methods and materials for the destruction of wastes and waste by-products.

Type of Research Needed:*

- Investigation of high temperature destruction of municipal and industrial wastes including:
 - improvements to state-of-the-art technology;
 - field and laboratory studies;
 - development of new technology for destruction and disposal of municipal and industrial wastes;
 - characterization of treatment residue, its leachability and utilization or disposal;
 - development of protocols for emission monitoring for hazardous contaminants;
- Investigation of non-thermal destruction of municipal and industrial wastes including:
 - development of mechanical and chemical methods
 - characterization of treatment residues

*See Also:

Air Quality Research:	Atmospheric Processes
	- AR04
Air Quality Research:	Sources/Inventories
	- AR08
Air Quality Research:	Instrument Development and Application
	- AR11
Air Quality Research:	Control and Remedial Technology
	- AR12
Analytical Method Development:	Landfill, Leachate, Effluent, Hazardous Waste Analysis
	- AN14
Analytical Method Development:	Air Analysis
	- AN16
Socio-Economic Research:	Costs of Controls and Mitigation
	- SE02

LIQUID AND SOLID WASTE RESEARCH: WASTE HANDLING

ISSUE: LS04

Methods for the ultimate disposal of wastes and waste by-products.

Type of Research Needed:*

- Investigation of ultimate fate of wastes and waste by-products.
- Determination of the impact of land application of wastes including effects on the quality of surface and groundwater and of soils.
- Determination of the cumulative effects of non-degradable contaminants on land.
- Study of "small quantity" waste disposal methods and practices, including definition of small quantity for specified materials.
- Development of criteria for waste-derived fuel (WDF).
- Assessment of risk associated with disposal methods.

*See Also:

Socio-Economic Research: Costs of Controls and Mitigation
- SE02

LIQUID AND SOLID WASTE RESEARCH: WASTE REDUCTION

ISSUE: LS05

Ways and means of reducing the volumes and contaminated mass of waste streams.

Type of Research Needed:*

- Studies of waste reduction at the levels of:
 - commercial
 - industrial
 - municipal
 - post-consumer
- Investigation of processing/packaging practices, methods and materials.
- Study of feasibility and need for segregating and stockpiling or selectively disposing of wastes in landfills for energy generation or possible future re-use.

***See Also:**

- Socio-Economic Research: Costs of Controls and Mitigation
- SE02
- Socio-Economic Research: Evaluation Tools and Applications
- SE03

LIQUID AND SOLID WASTE RESEARCH: WASTE REDUCTION

ISSUE: LS06

Ways and means of recycling materials currently in the waste stream.

Type of Research Needed:*

- Development of treatment methods to improve purity.
- Study of processes to alter compounds or characteristics of materials in the waste stream.

*See Also:

Socio-Economic Research: Costs of Controls and Mitigation
- SE02

Socio-Economic Research: Evaluation Tools and Applications
- SE03

LIQUID AND SOLID WASTE RESEARCH: WASTE REDUCTION

ISSUE: LS07

Ways and means of recovering usable materials currently in the waste stream.

Type of Research Needed: *

- Treatment of recovered material to protect and ensure purity.
- Processing of recovered material for direct reuse.
- Processing of recovered material for indirect and/or downstream use.

***See Also:**

- | | |
|--------------------------|-----------------------------------|
| Socio-Economic Research: | Costs of Controls and Mitigation |
| | - SE02 |
| Socio-Economic Research: | Evaluation Tools and Applications |
| | - SE03 |
| Socio-Economic Research: | Environmental Protection Industry |
| | - SE04 |

LIQUID AND SOLID WASTE RESEARCH: WASTE REDUCTION

ISSUE: LS08

Ways and means of re-using materials diverted from current waste stream.

Type of Research Needed:*

- Integration of re-use materials into production streams.
- Studies of innovative re-use of waste materials.
- Development of cross-industry sharing of reusable waste materials.

*See Also:

- | | |
|--------------------------|-----------------------------------|
| Socio-Economic Research: | Costs of Controls and Mitigation |
| | - SE02 |
| Socio-Economic Research: | Evaluation Tools and Applications |
| | - SE03 |
| Socio-Economic Research: | Environmental Protection Industry |
| | - SE04 |

LIQUID AND SOLID WASTE RESEARCH: LANDFILL TECHNOLOGY

ISSUE: LS09

Wastes and types of wastes being landfilled.

Type of Research Needed:*

- Determination of acceptable wastes.
- Determination of the effects of wastes on landfills.
- Investigation of rates of degradation and decomposition.
- Investigation of serial leaching and its effects.

*See Also:

Analytical Method Development: Landfill, Leachate, Effluent,
Hazardous Waste Analysis

- AN14

Socio-Economic Research:

Costs of Controls and Mitigation
- SE02

LIQUID AND SOLID WASTE RESEARCH: LANDFILL TECHNOLOGY

ISSUE: LS10

Methods, materials and performance of landfill covers.

Type of Research Needed:

- Development and evaluation of landfill cover designs in terms of:
 - materials
 - thickness
 - shape
 - infiltrative capacity
 - durability
 - rehabilitation and/or replacement

LIQUID AND SOLID WASTE RESEARCH: LANDFILL TECHNOLOGY

ISSUE: LS11

Methods, materials and performance of landfill liners.

Type of Research Needed:

- Development and evaluation of landfill liner designs in terms of:
 - materials
 - thickness
 - shape
 - leakage
 - durability
 - rehabilitation

LIQUID AND SOLID WASTE RESEARCH: LANDFILL TECHNOLOGY

ISSUE: LS12

Characteristics and impacts of landfill leachate.

Type of Research Needed:*

- Assessment of methods for collection, control and treatment of leachate.
- Determination of attenuation rates for leachate in groundwater.

*See Also:

Analytical Method Development: Landfill, Leachate, Effluent,
Hazardous Waste Analysis
- AN14

LIQUID AND SOLID WASTE RESEARCH: LANDFILL TECHNOLOGY

ISSUE: LS13

Production, control, collection and disposal of landfill gas.

Type of Research Needed:*

- Development of a method to assess methane flux.
- Development of specific measurement methods for ventilation rates and flux.
- Development of methods to enhance gas production rate.

*See Also:

Air Quality Research:	Instrument Development and Application
	- AR11
Socio-Economic Research:	Environmental Damages and Benefits
	- SE01

LIQUID AND SOLID WASTE RESEARCH: LANDFILL TECHNOLOGY

ISSUE: LS14

End-use of closed landfills.

Type of Research Needed:

- Development of closure techniques.
- Monitoring systems and materials for long term use.
- Study of legal and institutional impediments to future use.

LIQUID AND SOLID WASTE RESEARCH: LANDFILL TECHNOLOGY

ISSUE: LS15

Groundwater contamination from landfills.

Type of Research Needed:

- Investigations on the effects of leachates.
- Investigations on the effects of chemical spills.
- Development of methods for the improved detection and tracing of contaminant plumes.
- Development of methods for the improved prediction of plume development and movement.
- Development and demonstration of remediation methods and materials.
- Determination of "critical contaminant."

*See Also:

Water Quality Research:	Contaminant Fate and Transport Processes in Aquatic Systems - WA17
Analytical Method Development:	Landfill Leachate, Effluent, Hazardous Waste Analysis - AN13
Analytical Method Development:	Air and Water Analysis - AN15

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ANALYTICAL METHOD DEVELOPMENT RESEARCH NEEDS

ANALYTICAL METHODS DEVELOPMENT RESEARCH

Virtually every aspect of environmental research requires sample analysis. Sound methodologies are required for studies of a wide range of organic and inorganic contaminants of drinking and surface waters, groundwater, landfill leachates, ambient air, stack emissions, hazardous wastes, sewage and pulp and paper sludges, and biological systems. In addition to developing new methods for performing qualitative and quantitative determinations at trace levels in complex matrices, there is a constant need to improve existing methods to allow for analysis of more samples, better and faster. Specific research needs cover the gamut of analysis steps from sampling to analyte identification, quantification, and data interpretation.

Research is needed in the analytical area to determine the effect of sampling protocols on analytical data, especially for microbiological parameters. Field methods for pre-concentration of viruses and integrative biological tests to identify problem areas in air, soil and water are required. Rugged field collection methods for large-volume aqueous samples are needed using sorbent cartridges or other means. Associated sample preservation, shipping and storage protocols to ensure analyte stability are equally important. Techniques for odorous compounds in water and air and non-open collection methods to avoid atmospheric contamination or degassing of groundwaters/landfill leachates are of special importance. A validated, tiered testing protocol for groundwater contaminants is also required, in addition to improved methods for semi-volatile organics and trace metals in ambient air. Cannister sampling methods, plume dispersion models and improved prediction of precipitation events are all required to improve air and atmospheric deposition studies.

Samples often must be sub-aliquoted for analysis of multiple analytes and round-robin investigations. Effects of grinding, slicing, blending and other mixing and homogenization procedures on sample integrity need to be performed. Determination of analyte losses and the potential for artifact introduction and sample cross-contamination are especially important. Procedures to ensure the homogeneity of aqueous samples containing suspended particulates during sub-aliquoting also require investigation. Laboratory protocols for recovery and enumeration of pathogenic organisms need to be developed.

An ongoing need is to improve methods for the unambiguous identification of a broad range of organics in complex samples such as pulp and paper and sewage sludges. Methods to be investigated include advanced GC-MS techniques, FTIR, computer library matching, and other chemometrics techniques. Isolation and concentration methods to obtain large quantities of unidentified analytes are required to employ other spectroscopic techniques such as NMR. Improved chromatographic separation and HPLC fractionation techniques to simplify complex organic mixtures prior to mass spectrometry detection are also needed. Rapid

screening methods for trace metals in aqueous samples by using ICP-MS, GC-microwave plasma emission, or biological on-line monitoring are also of interest.

Microbiological identification enhancements are required for E. coli and group D. enterococci in water and sediments, as well as modification of such methods for the detection of other pathogens such as Salmonella and Campylobacteria. Similar methods to identify genotoxic compounds or conditions in the environment are needed. An ongoing problem is how to relate carcinogenicity and genotoxicity test responses to human health effects.

Improved quantification of target analytes is an ongoing research need. Development of novel GC detectors or improving the selectivity of conventional detectors is one approach to be considered. Development of improved cleanup techniques to isolate chemicals of concern also needs to be studied. the unambiguous determination of all 2,3,7,8-substituted dioxin/furan congeners is of special interest. To improve the quantitative analysis of selected target analytes in specific matrices, research is needed to develop validated analytical standards and SRMs.

For all of the preceeding studies improvement of sample throughput and the analytical precision and accuracy are desired. Approaches include chemometric techniques for data analysis including development of expert systems for data analysis, QA/QC, and troubleshooting analytical instruments. Other enhancements can be obtained through the use of robotics and development of new sample preparation methods more suited to automation. One area of special interest is the extraction/concentration of samples using supercritical fluids.

In addition to all of the above, some critical Ministry programs have special requirements. Of particular importance are laboratory techniques to assess the leaching potential of specific wastes for hazardous waste classification. Methods for complex industrial effluents for the MISA program are also important. Specific research is required to evaluate interferences for the determination of inorganics in MISA effluents, to develop improved analyte detectability by matrix modification, and to improve and validate methods for quantifying volatiles associated with liquid and solid fractions of sludges. Special problems have been encountered with the complex samples derived from pulp and paper industries, for which research is needed for sediment and biota tissue analysis of resin and fatty acids and speciated phenols. In addition, methods for flowthrough field analysis of pulp and paper effluents to determine the impact of mill discharges are required. Research is also needed to develop methods for the source tracking of pollutants in air and water. Chemometric methods are needed to compare organic/inorganic analyte profiles to identify generic sample types, to identify specific sources of such groups of compounds as PCBs, dioxin/furans and toxaphene by studying their congener/isomer patterns, and by studying isotope ratios of elements such as lead.

SUMMARY OF ANALYTICAL METHOD DEVELOPMENT ISSUES

RESEARCH CATEGORY	ISSUES	PAGE NUMBER	RELATED ISSUES AND PAGE NO.
<u>ANALYTICAL METHOD DEVELOPMENT</u>			
Refinement of Analytical Techniques	AN01 Specificity improvements to quantitative analysis of ultra trace analysis of organic compounds in complex mixtures	79	LS01/ 60
	AN02 Unambiguous identification of organic compounds in the environment	80	
	AN03 Automation of Analytical Methods.	81	
	AN04 Sample integrity and stability during shipping or storage.	82	
	AN05 Sample integrity after sub-aliquoting/ homogenization.	83	
	AN06 Validated analytical standards and standard reference materials	84	
	AN07 Expert System applications to analytical processes	85	
Drinking, Surface, Wastewater, Effluent Analysis	AN08 Broad spectrum screening for contaminants in drinking, surface and wastewaters	86	WA07/ 30
	AN09 Analytical method development to support MISA	87	

RESEARCH CATEGORY	ISSUES	PAGE NUMBER	RELATED ISSUES AND PAGE NO.
Drinking, Surface, Wastewater, Effluent Analysis (continued)	AN10 Large volume sampling systems for preconcentration of low level toxic contaminants	88	
	AN11 Surrogate parameters for water monitoring	89	WA01/ 24 WA02/ 25 WA05/ 28 WA20/ 43
	AN12 Sampling protocols for contaminants in surface and drinking waters	90	
Landfill, Leachate, Effluent, Hazardous Waste Analysis	AN13 Tiered testing of ground-water for landfill investigations	91	LS15/ 74
	AN14 Analytical method development to assess leaching potential of specific wastes for hazardous waste classification	92	LS03/ 62 LS09/ 68 LS12/ 71
Air and Water Analysis	AN15 Isotope ratios and isomer distribution patterns techniques as applied to source tracking of pollutants	93	AR06/ 11 WA08/ 31 WA17/ 40 LS15/ 74
Air analysis	AN16 Sampling and analysis of gaseous and particulate emissions in air	94	AR08/ 13 AR11/ 16 LS03/ 62
Biological Analysis	AN17 Biological toxicity testing	95	WA01/ 24 WA20/ 43 WA24 47 WA25/ 48 AR07/ 12
	AN18 Genotoxicity testing	96	
	AN19 Microbiological identification advancements	97	

ANALYTICAL METHOD DEVELOPMENT: REFINEMENT OF
ANALYTICAL TECHNIQUES

ISSUE: AN01

Specificity improvements to quantitative analysis of ultra trace analysis of organic compounds in complex mixtures.

Type of Research Needed:*

- Improvement of resolution in gas chromatography by development of new columns with novel stationary phases with high selectivity for priority pollutants.
- Construction of novel GC detectors or improvement of selectivity of conventional GC detectors for hazardous compounds.
- Development of new and improved chemical techniques for the isolation of target compounds from complex matrices of many other compounds including structurally similar species that interfere with GC and GC-MS analysis; includes wet chemical techniques, GPC, HPLC and other chromatographic separations.
- Extension of existing methods to handle new types of samples or target analytes.
- Development of rapid speciation methods for the toxic 2,3,7,8-substituted congeners of chlorinated dibenzo-p-dioxins and dibenzofurans in complex mixtures containing both toxic and non-toxic congeners.
- Development of identification procedures using combined retention time and mass spectral data for GC-MS; development of a retention indices system either generically with n-alkanes or specifically with deuterated compounds of interest.

*See also:

Liquid & Solid Waste Research: Waste Handling
- LS01

ANALYTICAL METHOD DEVELOPMENT: REFINEMENT OF
ANALYTICAL TECHNIQUES

ISSUE: AN02

Unambiguous identification of organic compounds in the environment.

Type of Research Needed:

- Improvements to GC-MS and other instrumental techniques for rapid broad-spectrum compound identification in extremely complex mixtures.
- Improvements to identification techniques of unknown organics from mass spectral information when library search methods are inadequate.
- Development of mathematical and software fingerprinting techniques for rapid broad-spectrum compound identification in extremely complex mixtures.
- Identification using specialized mass spectrometric techniques such as positive and negative chemical ionization, exact mass determination, and MS-MS.
- Development of isolation and concentration techniques to obtain large quantities of unknown components to enable a wide variety of spectroscopic techniques to be used for compound identification.
- Development of instrumental analysis procedures to supplement GC-MS identification including FTIR, interfaced to GC high performance liquid chromatography; NMR; use of GC-IR-MS and other specialized detectors for low level qualitative/quantitative analysis.
- Improvements to existing separatory techniques for superior fractionation of complex sample matrices for instrumental analysis (e.g. GC-MS, FTIR, SFC-MS).

ANALYTICAL METHOD DEVELOPMENT: REFINEMENT OF
ANALYTICAL TECHNIQUES

ISSUE: AN03

Automation of Analytical Methods.

Type of Research Needed:

- Development of software techniques to improve reliability of automated identification of trace levels of analytes using a few characteristic ion masses by selected ion monitoring or a series of peak retention times and relative responses.
- Improvement to software methods for automated target compound quantitation using external or internal standardization and automated report generation for GC-MS.
- Development of customized software packages for GC-MS data interpretation for specific Ministry programs, including specialized data bases.
- Development of improved identification procedures for complex mixtures such as environmentally altered PCB, toxaphene, chloronaphthalenes.
- Application of robotics to sample preparation operations, especially where sample mixing is required.
- Development of new extraction/wet chemical techniques more readily adapted to automation.
- Adaptation of existing chemical cleanup methods to automated procedures.
- Investigation and refinement of super critical fluid extraction and preparative chromatography techniques.

ANALYTICAL METHOD DEVELOPMENT: REFINEMENT OF
ANALYTICAL TECHNIQUES

ISSUE: AN04

Sample integrity and stability during shipping or storage.

Type of Research Needed:

- Determination of optimum conditions for shipping samples including time limitations, temperature effects, container design, addition of preservatives during sampling.
- Determination of sample integrity during length of storage time under different conditions, especially for volatile organic compounds.
- Determination of sample integrity during storage including time limitations, temperature effects, addition of preservatives, especially for inorganic parameters such as phenolics, nutrients, and alkalinity and for organics such as dioxins, PCB, organo-chlorines, PAH, chlorobenzenes; sample matrices of interest are ground waters, surface waters, leachates, fish and sediments.
- Comprehensive assessment of the stability with time of all inorganic and organic parameters routinely reported by MOE.
- Development of improved procedures where current techniques prove inadequate.
- Development of internal standards for organic analysis test groups to enable determination of sample integrity and stability during wet chemistry preparation.

ANALYTICAL METHOD DEVELOPMENT: REFINEMENT OF
ANALYTICAL TECHNIQUES

ISSUE: AN05

Sample integrity after sub-aliquoting/homogenization.

Type of Research Needed:

- Investigation of the effects of grinding, slicing, mixing, blending on homogeneity of sample and particle sizes.
- Investigation of analyte losses through sample homogenization steps or artifact introduction (i.e. trace metals using metal blender blades).
- Investigation of the homogeneity of an aqueous sample in the presence of suspended particulates during sample sub-aliquoting. Investigation of conditions when filtering should be conducted.
- Investigations of problems associated with splitting filter and polyurethane foam cartridged samples for air particulate.
- Development of protocol for sub-aliquoting complex samples for round robin samples.

ANALYTICAL METHOD DEVELOPMENT: REFINEMENT OF
ANALYTICAL TECHNIQUES

ISSUE: AN06

Validated analytical standards and standard reference materials.

Type of Research Needed:

- Synthesis, purification, quantification and validation of standard reference compounds such as dioxins, furans, PAH's, acetylated and methylated phenols, phenoxy, herbicides speciated phenols and acetylated nitrophenols as required for MOE laboratories and not available commercially.
- Development of Methods for validating standard concentrations.
- Development of Protocols for preparation, storage and use of analytical standards (long term stability of standard solutions). Including ampouling, freezing, storage under argon, or other inert gas.

ANALYTICAL METHOD DEVELOPMENT: REFINEMENT OF
ANALYTICAL TECHNIQUES

ISSUE: AN07

Expert system applications to analytical processes.

Type of Research Needed:

- Design IBM compatible systems using a rule based process to extract information to aid in the processing of large amounts of data.
- Development of expert systems to aid in troubleshooting analytical instrumentation: GC, GC-MS, HPLC, ICP-MS.etc.

ANALYTICAL METHOD DEVELOPMENT: DRINKING, SURFACE,
WASTEWATER ANALYSIS

ISSUE: AN08

Broad spectrum screening for contaminants in drinking, surface and wastewaters.

Type of Research Needed:*

- Development of ICP-MS, GC-microwave plasma emission spectroscopy, ion specific mass detector, biological on-line monitoring for screening trace metals in a variety of environmental samples.

*See also:

Water Quality Research: Municipal Wastewater treatment
- WA07

ANALYTICAL METHOD DEVELOPMENT: DRINKING, SURFACE,
WASTEWATER ANALYSIS

ISSUE: AN09

Analytical method development to support MISA.

Type of Research Needed:

- Evaluation of the possible interferences in the analysis of inorganic parameters in aqueous wastes from industrial operations.
- Investigation of matrix modification techniques to enhance specific analyte detectability and response.
- Development of methodology for quantifying trace contaminants (volatiles especially) associated with liquid and solid fractions of sludges.
- Development of standard protocols for sediment and biota tissue analysis of resin and fatty acids and speciated phenols related to pulp and paper.
- Development of flowthrough field analysis of colour and fluorescence in pulp and paper mill effluents for rapid detection to identify the extent of impact of mill discharges.

ANALYTICAL METHOD DEVELOPMENT: DRINKING, SURFACE,
WASTEWATER ANALYSIS

ISSUE: AN10

Large volume sampling systems for preconcentration of low level toxic contaminants.

Type of Research Needed:

- Extension and testing of resin technology for a comprehensive range of trace organics. Development of rugged high flow field sampling systems.
- Evaluation of the capacity of resin system to recover total organic loading from waters and waste waters.
- Evaluation of the effect of suspended particulate on the distribution and collection of organics in water.
- Development of resin columns for single step extraction and clean-up at present method detection limits.
- Extension of development of single step extraction/clean-up columns to allow lower detection limits.

ANALYTICAL METHOD DEVELOPMENT: DRINKING, SURFACE,
WASTEWATER ANALYSIS

ISSUE: AN11

Surrogate parameters for water monitoring.

Type of Research Needed:*

- Development, improvement and evaluation of effectiveness of detection limits of surrogate parameters and correlation with specific and group toxic compounds in drinking and waste waters.

*See also:

- | | |
|-------------------------|------------------------------------|
| Water Quality Research: | Industrial Waste Water Treatment |
| | - WA01 |
| | - WA02 |
| Water Quality Research: | Municipal Wastewater Treatment |
| | - WA05 |
| Water Quality Research: | Impacts of Pollutant Discharges on |
| | Aquatic Systems |
| | - WA20 |

ANALYTICAL METHOD DEVELOPMENT: DRINKING, SURFACE,
WASTEWATER ANALYSIS

ISSUE: AN12

Sampling protocols for contaminants in surface and drinking waters.

Type of Research Needed:

- Determination of significance of sampling protocols on analytical data. Protocols should also consider microbiological parameters other than the standard coliforms etc.
- Development/evaluation of samplers for collection of liquid samples (sewage effluent, drinking water, etc) for purgeable organic analysis.
- Evaluation of sampling and preservation techniques for purgeable and extractable organic analysis.
- Investigation of non-open sample collection methodologies to avoid atmospheric contamination of groundwater sampling and degassing of dissolved gases (N_2 , CO_2 etc.)

ANALYTICAL METHOD DEVELOPMENT: LANDFILL LEACHATE, EFFLUENT,
HAZARDOUS WASTE ANALYSIS

ISSUE: AN13

Tiered testing of ground-water for landfill investigations.

Type of Research Needed:*

- Development of a tiered testing protocol including validation of sample integrity for groundwater contaminant analysis.
- Ruggedness testing and development/refinement of analysers for wastewaters, landfill leachates groundwater.

*See also:

Liquid & Solid Waste Research: Groundwater contamination
- LS15

ANALYTICAL METHOD DEVELOPMENT: LANDFILL LEACHATE, EFFLUENT,
HAZARDOUS WASTE ANALYSIS

ISSUE: AN14

Analytical method development to assess leaching potential of specific wastes for hazardous waste classification.

Type of Research Needed:*

- Development of serial leaching procedures for specific wastes to determine the effect on contaminant concentration.
- Development of a simplified procedure to determine the effect of long term (serial) leaching.
- Investigation of alternate leaching procedures and development of procedures and protocols suitable for volatile and non-volatile organics.

*See also:

Liquid & Solid Waste Research: Waste Handling
- LS03

Liquid & Solid Waste Research: Landfill Technology
- LS09
- LS12

ANALYTICAL METHOD DEVELOPMENT: AIR AND WATER ANALYSIS

ISSUE: AN15

Isotope ratios and isomer distribution patterns techniques as applied to source tracking of pollutants.

Type of Research Needed:*

By applying advanced analytical techniques such as computerized GC-MS, FTIR, GC-MS, XRD, ICP-MS:

- Development of methods for comparing profiles of organics/inorganics for generic identification for sample types such as coal tar.
- Comparison and relationship to source of isomer distribution patterns for compounds such as PCB, toxaphene, dioxins.
- Investigation of relationship of emission patterns to sources using surrogates and isotope ratios of elements, such as Pb.
- Evaluation of the relationship of naturally occurring isotopic fractionation mechanisms to sources.
- Evaluation and relationship to sources of isotopic ratios in elements found in coal, lead, and zinc deposits etc. for various geologic regimes (Cambrian, Paleozoic, Mesozoic etc.)

*See also:

Air Quality Research:	Atmospheric Processes - AR06
Water Quality Research:	Managing Non-point sources of Pollution - WA08
Water Quality Research:	Contaminant Fate & Transport Processes in Aquatic System - WA17
Liquid & Solid Waste Research:	Groundwater contamination - LS15

ANALYTICAL METHOD DEVELOPMENT: AIR ANALYSIS

ISSUE: AN16

Sampling and analysis of gaseous and particulate emissions in air.

Type of Research Needed:*

- Development of broad spectrum screening methods to extend the range of compounds currently monitored to include odorous compounds such as mercaptans and amines and to provide a more rapid and cost effective approach to analysis of organic air pollutants.
- Further development of air sampling and analytical methods for both on and off-site measurements for semi-volatile and trace metals.
- Development of simple, rugged field analytical methods for landfill air contaminants emissions.
- Development of broad spectrum screening methods to extend the range of PAH currently monitored with emphasis on specificity.
- Development of cost-effective analytical methods for PAH, nitro PAH and CDD/CDF.
- Development of improved sampling methods to determine the vapour/particulate distribution of PAH and CDD/CDF in ambient air.
- Automation of sample preparation for air samples.
- Development of cryogenic purge and trap techniques for odorous problems in water.
- Development of routine method for the use of canister sampling for volatile organics.
- Evaluation of Plume dispersion models for point sources to aid in sample collection.
- Evaluation of improved prediction of precipitation events to aid in sample collection.

***See also:**

Air Quality Research:	Sources/Inventories
	- AR08
Air Quality Research:	Instrument Development & Application
	- AR11
Liquid & Solid Waste Research:	Waste Handling
	- LS03

ANALYTICAL METHOD DEVELOPMENT: BIOLOGICAL ANALYSIS

ISSUE: AN17

Biological toxicity testing.

Type of Research Needed:*

- Development of standardized on-site integrative biological tests to identify potential problem areas in air, soil and water.
- Development of laboratory protocols for recovery, identification, and enumeration of pathogenic organisms (virus, bacteria, protozoa).
- Development of field methods for pre-concentration of viruses.

*See also:

Water Quality Research:	Including Wastewater Treatment
	- WA01
Water Quality Research:	Impacts of Pollutant Discharges on
	Aquatic Systems
	- WA20
	- WA24
	- WA25
Air Quality Research:	Risk Management
	- AR07

ANALYTICAL METHOD DEVELOPMENT: BIOLOGICAL ANALYSIS

ISSUE: AN18

Genotoxicity testing.

Type of Research Needed:

- Development of in-situ test systems to identify the presence of genotoxic compounds or conditions (mixture effects) in the environment.
- Development of laboratory screening tests that can be quickly and economically carried out on environmental samples.
- Development of relationships between carcinogenicity and genotoxicity test response and human health effects.
- Examination of effects of mixtures of resin acids with single effects on biota.

ANALYTICAL METHOD DEVELOPMENT: BIOLOGICAL ANALYSIS

ISSUE: AN19

Microbiological identification advancements.

Type of Research Needed:

- Development of fluorescent antibodies to an antigen common to E. coli (as many serotypes as possible) and to an antigen common to group D enterococci.
- Development use of image analyser and computer to automatically count and compute the concentration of E. Coli and group D enterococci in water and sediment.
- Further modification of the above techniques for the detection of other pathogenic bacteria such as; Salmonella, Campylobacteria etc.

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SOCIO-ECONOMIC RESEARCH NEEDS

SOCIO-ECONOMIC RESEARCH

With the onset of environmental awareness in North America in the late 1960's, environmental protection was felt by many to transcend economic constraints and considerations. Indeed, economic considerations were perceived by environmental advocates to be impediments to the achievement of environmental goals. Because environmental resources and human health threatened by pollutants were considered to be priceless by many people, none of the statutes that were enacted at that time made any mention of economic implications or justification. However, it was soon discovered that resources to implement environmental protection programs were limited and trade-offs had to be made among programs, timing and achievements. Economic principles provide framework and criteria for making these trade-offs.

By the early 1980's, the role of economics in the Ministry was well established. However, nearly every issue that was investigated raised new questions and identified important information gaps. It was then that a Socio-economic component was added to the Environmental Research Program administered through the Research Advisory Committee (RAC). Since the inception of this component, the RAC has supported projects on the economics of hazardous waste transport, biotechnology policy, methods to value non-market goods and services, determinants of participation in solid waste source separation and the costs of advanced wastewater treatment methods for metal finishing and plating processes.

Topics for research on economic environmental linkages are listed under six primary issues or subject areas:

- quantification and valuation of pollution damages, risks and disruptions;
- determination of the costs of pollution abatement and environmental protection and their implications;
- development of evaluation tools and their application to proposed policies or programs;
- assessments of industries and businesses which develop and manufacture environmental protection technologies, equipment, products and services;
- social implications of environmental contaminants and their control.
- development and testing of forecasting, simulation and optimization models.

There is a particular need for application of risk assessment methodologies, valuation of risk reductions and methods to develop reliable inventories of resources at risk. The key factors which motivate private sector decisions regarding technology choice and

environmental program implementation are also of interest. Information is needed about technologies for groundwater protection and cleanup and their costs.

Insights about the factors that could allay citizens' fears and anxieties regarding the location of solid waste incinerator, processing and disposal sites are needed as well as research that will help implement composting, source separation and other waste reduction practices.

Finally, empirical studies which show how measurable pollution discharges or environmental quality conditions actually affect human uses, activities, expenditures and perceptions are especially needed for use in regulation development and evaluation activities.

It is clear that there are socio-economic aspects concerning virtually every environmental problem or issue. It is also clear that, in the context of the Ministry's RAC program, the socio-economic component provides the opportunity to integrate widely disparate bio-physical, social and economic data into policy relevant frameworks.

SUMMARY OF SOCIO-ECONOMIC RESEARCH ISSUES

RESEARCH CATEGORY	ISSUES	PAGE NUMBER	RELATED ISSUES AND PAGE NO.
<u>SOCIO-ECONOMIC RESEARCH</u>			
Environmental Damages and Benefits	SE01 Quantification and valuation of pollution damages, risks and disruptions and the benefits of environmental protection and of sustainable development	102	AR01/ 6 AR02/ 7 AR03/ 8 WA23/ 46 WA24/ 47 WA26/ 49 WA30/ 53 LS13/ 72
Costs of Controls and Mitigation	SE02 Determination of the costs and other economic consequences of environmental protection and pollution and pollution abatement activities	104	AR04/ 9 AR08/ 13 AR10/ 15 AR12/ 17 WA01/ 24 WA02/ 25 WA03/ 26 WA04/ 27 WA06/ 29 WA14/ 37 LS02/ 61 LS03/ 62 LS04/ 63 LS05/ 64 LS06/ 65 LS07/ 66 LS08/ 67 LS09/ 68
Evaluation Tools and Applications	SE03 Development and application of procedures and methods to evaluate policies, programs and projects	105	AR07/ 12 WA04/ 27 WA07/ 30 WA23/ 46 WA26/ 49 WA32/ 55 LS05/ 64 LS06/ 65 LS07/ 66 LS08/ 67
Environmental Protection Industry	SE04 Assessment of the characteristics, structure and performance of environmental protection related industries and businesses	106	AR12/ 17 LS07/ 66 LS08/ 67

RESEARCH CATEGORY	ISSUES	PAGE NUMBER	RELATED ISSUES AND PAGE NO.
Social (Non-Economic) Implications	SE05 Social implications of environmental contaminants and their control	107	
Enviro-Economic Modelling	SE06 Development and testing of forecasting simulation and optimization models	108	AR04/ 9 AR06/ 11 WA21/ 44 WA29/ 52 WA33/ 56

SOCIO-ECONOMIC RESEARCH: ENVIRONMENTAL DAMAGES AND BENEFITS

ISSUE: SE01

Quantification and valuation of pollution damages, risks and disruptions and the benefits of environmental protection and of sustainable development.

Type of Research Needed: *

- Develop and apply methods to determine the relative importance people place on different types of risk (including voluntary risks and both short and long-term risks) and how much people value reductions in such risks.
- Develop estimates of the specific short and long term costs and expenditures caused by environmental effects and damages (eg. health care, lost wages, corrosion losses, etc.)
- Conduct behavioral experiments to determine individuals' actual willingness-to-pay or willingness-to-accept-compensation values for specific environmental features or attributes.
- Compare the results of different valuation methodologies for similar non-market environmental goods or activities.
- Develop quantitative relationships between water quality measures/indicators and uses of water bodies for swimming, fishing, boating and other recreational activities.
- Develop and apply methods to produce inventories of various resources at risk.
- Develop and test procedures to quantify various types of environmental damages and to assign measures of relative importance, taking into account reversability of damages.
- Determine the relative importance that people place on odours from urban and/or rural sources and the value people attribute to reductions in odours.
- Conduct field tests and evaluate the importance that people place on the extent, volume and type of noise arising from outside sources that appear to impact adversely on the right to enjoy one's property in peace.
- Quantify and estimate the values of the beneficial (crop productivity, reductions in annoyance and health risk, etc.) and adverse (increased risk of contamination and health effects, damages to wildlife, etc.) effects of pesticide use.

continued. . .

SOCIO-ECONOMIC RESEARCH: ENVIRONMENTAL DAMAGES AND BENEFITS

ISSUE: SE01 (continued)

- Develop estimates of damages due to ground water contamination and the costs and benefits of its prevention or mitigation including the consequences of change in sustainable rates of water use.
- Adapt or develop human health and risk dose-response relationship functions for toxic-hazardous waterborne and airborne compounds to predict and quantify damages from specific pollutants, economic activities or development projects, taking into account both short-term and long-term consequences.
- Determine the external economic effects of waste disposal and processing sites with specific reference to likelihood and timing.
- Adapt or develop human health and risk dose-response relationships for toxic substances to predict and quantify the beneficial consequences that result from abatement and protection activities.
- Document the private benefits (e.g. recovered by-products, cost reductions, raw material and energy savings, product quality improvements, etc.) of industrial abatement technologies, systems, or programs and the implications of such benefits on investment and growth.
- Compare methods of valuing marginal changes with those for valuing extinction, all or nothing situations or catastrophies.

***See Also:**

Air Quality Research:	Contaminant Effects/Toxicology/ Fates - AR01 - AR02 - AR03
Water Quality Research:	Impacts of Pollutant Discharges on Aquatic Systems - WA23 - WA24
Water Quality Research:	Drinking Water - WA26
Water Quality Research:	Effects of Acidic Deposition and the Long Range Transport of Contaminants - WA30
Water Quality Research:	Other - WA32
Liquid and Solid Waste Research:	Landfill Technology - LS13

SOCIO-ECONOMIC RESEARCH: COSTS OF CONTROLS AND MITIGATION

ISSUE: SE02

Determination of the costs and other economic consequences of environmental protection and pollution abatement activities

Type of Research Needed:*

- Develop abatement cost functions for particular pollutants in specific industries which can be used in future studies and assessments.
- Estimation of the costs of controlling air emissions from fuel burning by households and commercial units.
- Cost effectiveness of monitoring strategies.
- Analysis of demand characteristics and price elasticities for pollution abatement systems, services and equipment.
- Determine the motivating factors for industrial and municipal decision-makers with respect to abatement/environmental protection programs including any perceived tradeoffs between current and future welfare.
- Compare the costs and other implications of "up front" mine rehabilitation measures with post closure clean-up practices.
- Document the distribution of environmental protection costs.

*See Also:

Air Quality Research:	Atmospheric Processes
	- AR04
Air Quality Research:	Sources/Inventories
	- AR08 - AR10
Air Quality Research:	Control and Remedial Technology
	- AR12
Water Quality Research:	Industrial Wastewater Treatment
	- WA01 - WA02 - WA03 - WA04
Water Quality Research:	Municipal Wastewater Treatment
	- WA06
Water Quality Research:	Managing Non-Point Sources of Pollution
	- WA14
Liquid and Solid Waste Research:	Waste Handling
	- LS02 - LS03 - LS04
Liquid and Solid Waste Research:	Waste Reduction
	- LS05 - LS06 - LS07 - LS08
Liquid and Solid Waste Research:	Landfill Technology
	- LS09

SOCIO-ECONOMIC RESEARCH: EVALUATION TOOLS AND APPLICATION

ISSUE: SE03

Development and application of procedures and methods to evaluate policies, programs and projects

Type of Research Needed: *

- Conduct benefit-cost analyses of specific environmental protection programs, sustainable development projects or activities.
- Design and test economic incentive policy instruments such as effluent charges or emission rights schemes.
- Application of linear programming techniques to identify cost-effective abatement strategies.
- Determination of polluters' responses and behaviour to different regulatory instruments and approaches.
- Compare non-economic evaluation techniques with benefit-cost analysis. Will such methods as the Judgemental Impact Matrix, forms of social impact assessment, risk assessments or net energy analysis yield the same conclusions as benefit-cost analysis given the same input data?
- Develop criteria for evaluating and making decisions concerning conservation and/or enhancement of productive capability, environmental quality, and renewable resources accruing over extremely long periods of time in contrast to conventional approaches to discounting future benefits.

***See Also**

Air Quality Research:	Risk Management/Criteria Development - AR07
Water Quality Research:	Industrial Wastewater Treatment - WA04
Water Quality Research:	Municipal Wastewater Treatment - WA07
Water Quality Research:	Impacts of Pollutant Discharges on Aquatic Systems - WA23
Water Quality Research:	Drinking Water - WA26
Water Quality Research:	Other - WA32
Liquid and Solid Waste Research:	Waste Reduction - LS05 - LS06 - LS07 - LS08

SOCIO-ECONOMIC RESEARCH: ENVIRONMENTAL PROTECTION INDUSTRY

ISSUE: SE04

Assessment of the characteristics, structure and performance of environmental protection related industries and businesses

Type of Research Needed:*

- Development and testing of environmental auditing procedures.
- Determination of price elasticities and other factors which affect the demand for secondary materials.
- Determinants of innovation in pollution abatement/ resource recovery technology.
- Exploration of the factors and experience which concern the development and choice of pollution control and prevention technologies.
- Determination of the economic dimensions, structure and performance of firms and industries which manufacture and sell pollution control equipment and supplies or which supply environmental protection services.
- Assessment of the economic implications of the regulation of biotechnology applications.

*See Also

Air Quality Research:

Control and Remedial Technology

- AR12

Liquid and Solid Waste
Research:

Waste Reduction

- LS07 - LS08

SOCIO-ECONOMIC RESEARCH: SOCIAL (NON-ECONOMIC) IMPLICATIONS

ISSUE: SE05

Social implications of environmental contaminants and their control

Type of Research Needed:

- Development of a more comprehensive understanding of the social and psychological impacts of individual and community exposure to environmental contaminants, particularly in terms of:
 - . the identification of factors that determine such impacts and processes by which they are manifested; and
 - . the development and evaluation of strategies for predicting, preventing and/or mitigating social and psychological impacts.
- Identification of factors which determine public perceptions of, and responses to, voluntary and/or involuntary risks associated with environmental contaminants.
- Determination of emitters' or dischargers' perception of risk and/or costs due to potential prosecutions or other adverse consequences of non-compliance compared with the statistical experience of having violations detected, prosecuted, convicted and fined.
- Development and evaluation of approaches for communicating information about environmental hazards and risks to the public.
- Empirical evaluation of different approaches to consulting the public on environmental issues.
- Development of new approaches or methodologies for predicting the social impacts of changes (improvements or decrements) in environmental quality.
- Assess theoretical foundations of benefit cost analysis, propose alternative ethical paradigms and test with case studies.
- Develop and apply measures of social effects of waste disposal and processing sites.

SOCIO-ECONOMIC RESEARCH: ENVIRO-ECONOMIC MODELLING

ISSUE: SE06

Development and testing of forecasting simulation and optimization models

Type of Research Needed: *

- Comparisons of statistical and economic techniques and models to forecast:
 - . control technology changes;
 - . contaminant discharges/emissions; and
 - . spills.
- Development and testing of models which link and integrate economic activities and environmental systems.
- Development of bio-economic models and software to simulate and evaluate the consequences of possible pollution scenarios.
- Development of models to analyze economic and financial impacts of environmental requirements at the level of the farm, industry or the provincial economy.

*See Also

Air Quality Research:	Atmospheric Processes
	- AR04 - AR06
Water Quality Research:	Impacts of Pollutant Dischargers in Aquatic Systems
	- WA21
Water Quality Research:	Effects of Acidic Deposition
	- WA29
Water Quality Research:	Other
	- WA33

GLOSSARY OF ABBREVIATIONS

APCI	Atmospheric Pressure Chemical Ionization
CDD/CDF	Chlorinated Dibenzodioxins/Chlorinated Dibenzofurans
CI	Chemical Ionization
CO ₂	Carbon Dioxide
CSO	Combined Sewer Overflow
EI	Electron Impact
EMPPPL	Effluent Monitoring Priority Pollutant List
FTIR	Fourier Transform Infrared Spectrometry
GAC	Granular Activated Carbon
GC	Gas Chromatography
GC-IR-MS	Gas Chromatography - Infra-red Spectroscopy - Mass Spectrometry
GC-MS	Gas Chromatography - Mass Spectrometry
GIS	Geographic Information System
GPC	Gel Permeation Chromatography
HPLC	High Pressure Liquid Chromatography
ICP	Inductively Coupled Plasma
K _{OW}	Octanol-Water Partitioning Coefficient
LRTAP	Long Range Transport of Air Pollutants
MISA	Municipal Industrial Strategy for Abatement
MOE	Ministry of the Environment
MS	Mass Spectrometry
MS-MS	Combined Mass Spectrometry - Mass Spectrometry, either quadrupole or magnetic sector
N ₂	Nitrogen
NMR	Nuclear Magnetic Resonance
PAC	Powdered Activated Carbon
PAH	Polynuclear Aromatic Hydrocarbons
PCB	Polychlorinated Biphenyls
PCCD	Polychlorinated Dibenzo Dioxins
PCDF	Polychlorinated Dibenzo Difurans
ppq	Part Per Quadrillion
ppt	Part Per Trillion
QA/QC	Quality Assurance/Quality Control
QSAR	Quantitative Structure Activity Relationship
SFC	Supercritical Fluid Chromatography
SRM	Standard Reference Materials
STP	Sewage Treatment Plant
SWR	Storm Water Runoff
TAGA	Trace Atmospheric Gas Analyser
XRD	X-ray Diffraction



FORM 02

FORMULE 02

Application For
Research Funding

Demande de financement
de projets de recherche

Ministry Use Only Réserve au ministère	
Date Received Date de réception	_____
Proposal No. Proposition n°	_____
Research Area Domaine de recherche	_____

This form is to be completed by the applicant for the benefit of the Ministry of the Environment and is intended to provide a summary of the detailed proposal. The Form 02 summary is the description of the proposal that will be submitted to the Research Advisory Committee for their review along with the reviewers' recommendations for funding. Five copies and the original of all documents are required when submitting an unsolicited or solicited proposal for funding by grant or contract.

The detailed proposal should include a thorough review of the available literature to support the rationale and objectives. All submissions should include clearly stated objectives and a full description of proposed methods, a detailed cost breakdown, a discussion of the anticipated contribution to the field of environmental research, and an appended list of relevant publications and curriculum vitae. Information must also be provided for any specialists or co-investigators named.

Generally, proposals should not exceed 20 pages in length, exclusive of supplementary appendices. The closing dates for the receipt of unsolicited proposals are January 15 and June 15. If approved, funding is effective upon notification by the Ministry (generally in May and October respectively).

CONDITIONS OF AWARD OF GRANT OR CONTRACT

In the event that a grant or contract is awarded, the principal investigator and his/her institution or company agree to:

1. Provide the Research Advisory Committee, Ministry of the Environment, with a written final report (galley-proof) plus five copies on the work completed during the project year (s) and with copies of all reports or publications resulting from this project. This may include supporting operational documents and software copies.

It is understood that release or publication of the final report is contingent on approval by the Ministry of the Environment.

2. Execute an agreement on the Ministry's standard form before funds can be advanced.
3. Provide a progress report every six months in addition to the final report.
4. Provide a statement of grant expenditures at the end of each fiscal year (March 31) to the Liaison Officer and the Research Management Office.
5. Present a paper at the annual Technology Transfer Conference, if requested.
6. Provide to the Liaison Officer at the end of each project year a list of capital equipment purchased with grant or contract monies.
7. Immediately notify the Liaison Officer of any change in the scope or nature of the work program, and return all grant funds to the Ministry not required to carry out the approved, revised program. Major changes in scope require prior approval and contract amendment.
8. Return to the Ministry all grant funds remaining at the completion of the project.
9. Return all capital equipment purchased with grant or contract monies at the completion of the project or alternatively, make some other suitable arrangement in writing with the Research Advisory Committee if the equipment will continue to be used to carry out related work.
10. Allocate no stipend or salary paid to a university Principal Investigator(s) from a grant.
11. Allow an Ontario Provincial Government Auditor access to the financial and/or project records either during or after its completion, if requested.

La présente formule, qui doit être remplie par le demandeur pour le ministère de l'Environnement, vise à résumer la proposition. La formule 02 résume la description de la proposition qui sera soumise à l'étude du Comité consultatif de la recherche, accompagnée des recommandations de financement faites par les examinateurs de la proposition. Cinq copies des documents de même que leurs originaux doivent accompagner la demande de financement, par subvention ou par contrat, de la proposition, sollicitée ou non.

La proposition doit comprendre une étude détaillée des ouvrages existants dans le domaine de recherche afin d'appuyer la justification et les objectifs du projet. De plus, la demande de subvention doit inclure la liste complète des objectifs poursuivis, la description détaillée des méthodes utilisées pour atteindre ces objectifs, la ventilation des coûts, l'examen de la contribution apportée par le projet à la recherche environnementale et, en annexe, le curriculum vitae de l'intéressé (ou des intéressés), fournissant la liste des publications. On doit également fournir des renseignements sur tous les spécialistes et chercheurs nommés dans la description du projet.

De façon générale, la proposition ne doit pas dépasser 20 pages, appendices non compris. Toute proposition non sollicitée doit parvenir au ministère pour le 15 janvier ou le 15 juin. S'il est approuvé, le financement entre en vigueur lorsque le ministère avise le chercheur ou l'organisme de sa décision (généralement en mai et octobre).

CONDITIONS D'ATTRIBUTION D'UNE SUBVENTION OU D'UN CONTRAT

En cas d'attribution d'une subvention ou d'un contrat, le chercheur principal de même que l'organisme auquel il appartient s'engagent à :

1. Présenter par écrit au Comité consultatif de la recherche du ministère de l'Environnement un rapport final (épreuves en placard) et cinq copies sur les travaux effectués au cours du projet, comprenant des exemplaires de tous les rapports et publications, y compris les documents auxiliaires d'exploitation et les logiciels, résultant du projet.
Il est entendu que la diffusion ou la publication du rapport final dépend de l'approbation du ministère de l'Environnement.
2. Établir une entente sur le formulaire d'entente du ministère, avant d'avancer des fonds.
3. Présenter un compte rendu semestriel en plus du rapport final.
4. Faire vérifier et présenter, à la fin de l'exercice financier (31 mars), à l'agent de liaison et au Bureau de gestion de la recherche, un état des dépenses concernant la subvention.
5. Présenter, le cas échéant, une communication au congrès annuel sur le transfert des techniques.
6. Fournir à l'agent de liaison, tous les ans après le début du projet, la liste des biens d'équipement achetés grâce à la subvention, ou au contrat.
7. Aviser immédiatement l'agent de liaison de tout changement d'orientation des travaux et remettre au ministère toute partie de la subvention qui n'est pas nécessaire à la réalisation des nouveaux travaux. Les changements d'orientation importants doivent être préalablement approuvés, et les contrats modifiés.
8. Remettre au ministère la partie non utilisée de la subvention une fois le projet terminé.
9. Rendre tous les biens d'équipement achetés grâce à la subvention ou au contrat lorsque le projet est terminé, ou conclure une entente écrite appropriée avec le Comité consultatif de la recherche si ces biens doivent continuer à être utilisés pour des travaux connexes.
10. Ne pas utiliser une subvention pour verser des honoraires ou payer un salaire à un chercheur universitaire principal.
11. Permettre, le cas échéant, à un vérificateur du gouvernement de l'Ontario d'examiner les états financiers et les dossiers, pendant ou après le projet.



Ontario

Ministry
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EnvironmentMinistère
de
l'Environnement

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Proposal No. Proposition n°

Project No. Projet n°

Principal Investigator Chercheur principal

Affiliation Affiliation

Research Proposal Summary Résumé de la proposition de recherche

Research Area Domaine de recherche

Type of Funding applied for: ☐ Grant ☐ Contract ☐ Unsolicited ☐ Solicited
Type de financement demandé: Subvention Contrat Proposition non sollicitée Proposition sollicitéeTitle of Proposed Research
Titre de la recherche

Short Title Titre abrégé

% of Principal Investigator's Time (Allocated to the Project)
Pourcentage de son temps qu'alloue le chercheur au projet _____ %

Principal Investigator's Title Titre du chercheur principal

Address Adresse

City/Town Ville

Province Province

Postal Code Code postal

Tel. No. N° de téléphone

Co-Investigator(s) Autre(s) chercheur(s)

Affiliation Affiliation

1.

Affiliation Affiliation

2.

BUDGET BUDGET	1st Year 1 ^{re} année	2nd Year 2 ^e année	3rd Year 3 ^e année	TOTAL TOTAL
Salaries and Benefits Salaires et avantages sociaux				
Travel Déplacements				
Supplies and Equipment Matériel et équipement				
Overhead/Indirect Expenses (contractors only) Frais généraux et indirects (entreprise)				
Services (e.g. Computer Time) Services (p. ex. temps d'ordinateur)				
Other (specify) Autres (préciser)				
TOTAL TOTAL				
Total No. of Mandays Nombre total de jours de main-d'oeuvre				

Current or Previous Research Funding Financement de la recherche

Has this proposal or similar to it been submitted elsewhere for funding? Cette proposition, ou une semblable, a-t-elle fait l'objet d'une demande de financement auprès d'un autre organisme/ministère ?

☐ Yes Oui If yes, where?☐ No Non Dans l'affirmative, auprès de qui?

Has it been accepted?

A-t-elle été acceptée?

☐ Yes

Oui

☐ No

Non

If yes, total approved funds

Dans l'affirmative, montant du financement total approuvé

No. of Years

Nombre d'années

It is agreed that the general conditions as outlined in the Guideline for Proposal Submission apply to any grant or contract pursuant to this application and are hereby accepted by the applicant and the applicant's employing institution or company. Il est convenu que les conditions générales énumérées dans les Directives régissant la présentation des propositions s'appliquent à toute subvention ou contrat faisant l'objet de la présente demande et que le demandeur et son employeur acceptent ces conditions par la présente.

University Université

Dean, Head or Chairman Doyen, directeur ou président

Name Nom

Tel. No. N° de téléphone

Signature

Date

Financial Administrator Administrateur financier

Name Nom

Tel. No. N° de téléphone

Signature

Date

Director of Research Administration Directeur administratif de la recherche

Name Nom

Tel. No. N° de téléphone

Signature

Date

Principal Investigator Chercheur principal

Name Nom

Tel. No. N° de téléphone

Signature

Date

Contractor Entreprise

President or Principal Président ou directeur général

Name Nom

Tel. No. N° de téléphone

Signature

Date

Financial Administrator Administrateur financier

Name Nom

Tel. No. N° de téléphone

Signature

Date

Principal Investigator Chercheur principal

Name Nom

Tel. No. N° de téléphone

Signature

Date



Ontario

Ministry
of the
Environment

Ministère
de
l'Environnement

Principal Investigator Chercheur principal

Ministry Use Only Réserve au ministère

Proposal No. Proposition n°

Project No. Projet n°

Affiliation Affiliation

1. Abstract (For Full Study) Résumé (de l'étude)

2. Objective(s) Objectif(s)

3. Milestone Definition and Schedule (For Full Study) Définition et calendrier des étapes (de l'étude)

Milestone No. Étape n°	Description Description	Anticipated Date of Completion Date prévue de la fin de l'étape



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Proposal No. Proposition n° Project No. Projet n°

Affiliation Affiliation

Principal Investigator Chercheur principal

4. Study Description Description de l'étude

Year 1 of Study 1^{re} année de l'étude

Description Description

Anticipated Results Résultats prévus

Year 2 of Study 2^e année de l'étude

Description Description

Anticipated Results Résultats prévus

Year 3 of Study 3^e année de l'étude

Description Description

Anticipated Results Résultats prévus



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Project No. Projet n°

Affiliation Affiliation

5. Relevance and Potential for Application Pertinence du projet et possibilités d'applications

What will this project contribute to the Ministry of the Environment's research needs?
Comment le projet répondra-t-il aux besoins en recherche du ministère de l'Environnement?

Describe potential for implementation of results, potential users and time frame for application of results by users.
Décrivez les applications possibles des résultats du projet, indiquez les usagers éventuels et fournissez le calendrier de ces applications.

Potential Marketability – Please describe if applicable
Possibilités de commercialisation – Donnez-en une description le cas échéant.

DATE DUE			

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